The Industry Origins of

Japanese Economic Growth

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Abstract

This paper presents new data on the sources of growth for the Japanese economy over the period 1960-2000. The principal innovation is the incorporation of detailed information for individual industries, including those involved in the production of computers, communications equipment, and electronic components as information technology equipment. We show that economic growth is dominated by investments and productivity growth in information technology, both for individual industries and the economy as a whole. We also show that the revival of total factor productivity growth accounts for the modest resurgence of the Japanese economy since 1995.

JEL Codes: C82, D24, E23.

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This paper was presented at the 17th TRIO Conference at Keio University, Tokyo, on December 10, 2004. We have greatly extended our accounting system and incorporated new data on information technology since this presentation.

I. Introduction

Our objective in this paper is to quantify the sources of Japanese economic growth for 1960-2000, using data for individual industries. Industry-level data enable us to trace the sources of Japanese economic growth to its industry origins. A novel feature of these data is that we include the IT-producing industries – Computers, Communications Equipment, and Electronic Components.[1] We are able to assess the relative importance of productivity growth and capital accumulation at both industry and economy-wide levels. We divide productivity growth between the IT and Non-IT sectors and allocate capital accumulation between IT and Non-IT capital.

Productivity growth in the IT-producing industries has steadily risen in importance, generating a relentless decline in the prices of information technology equipment and software.[2] This decline in IT prices is rooted in developments in technology that are widely understood by technologists and economists, particularly the continuous improvement in the performance/price ratio of semiconductors captured by Moore's Law. Information technology has reduced the cost and improved the performance of products and services embraced by businesses, households, and governments. The enhanced role of investment in IT is a conspicuous feature of the Japanese economy and a growth revival is under way in many important IT-using industries.

The mechanisms for diffusion of advances in IT are two-fold. First, advances in semiconductors generate continuing price reductions for a given level of performance. These price reductions drive demands for intermediate inputs in semiconductor-using industries such as computers, communications equipment, and a host of others. Second, the industries that use semiconductors as inputs generate further price declines that drive investments in IT equipment like computers and telecommunications equipment. Advances in equipment production augment the downward pressure on prices, steadily redirecting the rising IT investment flow toward its most productive uses.[3]

Our major goal is to characterize the role of information technology in the Japanese economy. We also focus on the impact of IT during the long Japanese recession of the 1990's. There are three main challenges in isolating and analyzing the IT-producing industries in Japanese economy. The first is that the IT-producing industries are below the two-digit industrial classification used in previous studies of Japanese productivity, such as Jorgenson (1995), Nomura (2004a), and Fukao, Inui, Kawai, and Miyagawa (2004). In this paper, we have generated detailed data for these industries in order to characterize IT-production as precisely as possible. This enables us to quantify the impact of IT

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[1] Our methodology follows that of Jorgenson, Ho, and Stiroh (2005).
[2] See Jorgenson, Ho, and Stiroh (2005).
[3] Models of the interactions among semiconductor, computer, and other industries are presented by Dulberger (1993), Triplett (1996), and Oliner and Sichel (2000).

production on the Japanese economy more accurately and represents a substantial advantage over earlier studies using the broader industry aggregates.

The second challenge is the capitalization of investment in software in the Japanese national accounts. The official national accounts treat expenditures for custom software, mineral exploration, and plant engineering as gross fixed capital formation (GFCF) in intangible assets. Own-account software and pre-packaged software have not been capitalized, although this is recommended by the United Nations (1993) System of National Accounts 1993 (1993 SNA).[4] In this paper, we capitalize own-account software and pre-packaged software and rebalance the time-series of input-output tables given in Nomura (2004b). The methodology is similar to the one adopted by the Bureau of Economic Analysis (BEA) in the benchmark revision of the U.S. national accounts in 2003.

The third challenge is to construct appropriate prices for IT products. For example, Jorgenson (2004) analyses the sources of growth of the G7 economies at the aggregate level. He uses "internationally harmonized" IT prices based on U.S. prices. The use of harmonized prices is one possible approximation to quality-adjusted prices for countries whose statistical agencies do not adjust IT prices to eliminate quality change. However, the IT price statistics in Japan have already been quality-adjusted, so that internationally harmonized prices are unnecessary. Nomura and Samuels (2004) compare Japanese and U.S. IT prices and estimate the "best practice" IT prices for Japan that we employ in this paper. We also consider Japanese IT prices for output and investment, since these are critical in measuring productivity growth in Japanese industries, including IT-producing industries.

In addition to reconciling the national accounts for Japan with the 1993 SNA, we create a production account for the household sector and expand the Japanese accounts in three areas. We impute capital services for public capital, owner-occupied housing, and consumer durables. This makes it possible to compare the Japanese national accounts with the U.S. national accounts described in Jorgenson, Ho, and Stiroh (2005). The national accounting system employed in this paper includes a complete production account for the Jorgenson system of national accounts (Fraumeni, 2000; Jorgenson and Landefeld, 2005). This provides an appropriate valuation of capital services for fixed assets and land in non-market production. This will be considered in the next revision of the SNA in 2008 (1993 SNA Revision 1) or future revisions, as discussed in Ahmad (2004).

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[4] It is not evident why these categories of software were not capitalized. One reason might be that benchmark 1995 input-output (IO) table, one of basic sources for estimating the Japanese national accounts, treated only custom software as a software investment. The benchmark 2000 input-output table, published in the summer of 2004, treats pre-packaged software as GFCF. However, capitalization of own-account software was not included in the benchmark 2000 IO table. Due to constraints on data from the Japanese national accounts, own-account and pre-packaged software are not capitalized in previous studies of the Japanese growth accounts at the industry level, such as Nomura (2004a) and Fukao, Inui, Kawai, and Miyagawa (2004).

The remainder of this paper is organized as follows: Section II presents our methodology for measuring output and intermediate inputs. The most important feature is a consistent time series of inter-industry transactions tables that enables us to allocate the sources of Japanese economic growth among industries. In Section III we outline our methods for measuring capital input. Constant quality price indexes for information technology equipment are essential for separating the change in performance of this equipment from the change in price for a given level of performance. The cost of capital is the key concept for capturing the economic impact of information technology prices. Section IV outlines our methods for measuring labor input. These incorporate differences in hours worked and wages for workers who differ in age, sex, and, most important, educational attainment. We combine measures of industry output and capital, labor, and intermediate inputs to construct estimates of productivity by industry in Section V.

In Section VI we outline a framework for aggregating output, capital, labor, and intermediate inputs, and productivity over industries. This framework was introduced by Jorgenson, Gollop, and Fraumeni (1987). A key role is played by a weighting scheme proposed by Domar (1961), based on the relative importance of each industry in value added, as well as the relative importance of value added in the industry's output. The Domar weighting scheme captures the impact of sources of growth at the industry level, both in the industry where growth occurs and the industries that purchase the output of this industry. Section VII presents our analysis of the industry origins of Japanese economic growth over the period 1960-2000. The contributions of capital and labor inputs and gains in economy-wide productivity presented in Tables 2, 3, and 4 reflect the evolution of the production structure of all industries in the Japanese economy. We aggregate over industries in order to show how changes in production structure at the industry level cumulate to determine economy-wide economic growth. We focus special attention on the role of productivity growth in the IT-producing industries. Section VII concludes the paper.

II. Measuring Output, Intermediate Input, and Value Added.

i. Methodology

This section describes our methodology for measuring industry outputs, intermediate inputs, and value added. This uses a time series of input-output (IO) tables and was introduced by Jorgenson, Gollop, and Fraumeni (1987, Ch.5). We begin with a description of our definitions and notation:

Y_j quantity of output of industry j

$X_{i,j}$ quantity of input i into industry j

X_j total intermediate input into industry j

K_j	capital input into industry *j*
L_j	labor input into industry *j*
T_j	index of technology in industry *j*
Y_i^C	quantity of domestically produced commodity *i*
Y_i^S	quantity of total supply of commodity *i*
$M_{j,i}$	Make matrix; nominal value of commodity *i* made by industry *j*
V_j	quantity of value added in industry *j*
P_j^Y	price of output to producer in industry *j*
P_j^{YT}	price of output in industry *j* , including net indirect tax
P_i	price of commodity *i*
P_j^X	price of total intermediate input into industry *j*
P_j^K	price of total capital input into industry *j*
P_j^L	price of total labor input into industry *j*
P_i^{YC}	price of domestically produced commodity *i*
P_j^V	price of total value added in industry *j*
m_i	quantity of imports of commodity *i*
P_i^m	price of imported commodity *i*

We assume that the production function for industry *j* has *M* distinct intermediate inputs and is separable in these inputs, so that:

$$(2.1) \quad Y_j = f(K_j, L_j, X_j, T_j); \qquad X_j = x(X_{1,j}, X_{2,j}, ..., X_{M,j}),$$

where M =51; there are 47 commodities corresponding to the primary products of the industries listed in Table 5 and 4 non-competitive import goods for Japanese economy — Crude Oil, LNG, Iron Ore, and Other Non-competitive Imports. The second equation of Equation (2.1) is an aggregator function of intermediate inputs in industry *j*. Inputs of capital and labor, K_j and L_j, are also aggregated from the detailed categories for each input defined below.

Under the assumptions of constant returns to scale and competitive markets, the value of output is equal to the value of all inputs — capital, labor, and intermediate:

$$(2.2) \qquad P_j^Y Y_j = P_j^K K_j + P_j^L L_j + \sum_i P_i X_{i,j} ,$$

where we assume that the price of intermediate input P_i of commodity *i* is the same for all purchasing industries.

In the aggregator function of Equation (2.1), we define the quantity of intermediate input as a translog index of its components:

$$(2.3) \qquad \Delta \ln X_j = \sum_i \bar{v}_{i,j} \Delta \ln X_{i,j} ,$$

where the $\bar{v}_{i,j}$ weights are the average, two-period shares of the components in the value of intermediate input. The price index of intermediate input P_j^X is equal to the value of intermediate input, divided by the quantity index X_j. Note that this price is specific to industry *j*, even if the prices of the component inputs are the same for all industries, since the shares of the components differ among industries.

We require the concept of industry value added for aggregation over sectors in Section VI below. Assuming that the production function is separable in intermediate input and value added, we define industry value added V_j implicitly from the equation:

$$(2.4) \qquad \Delta \ln Y_j = (1 - \bar{v}_j^V) \Delta \ln X_j + \bar{v}_j^V \Delta \ln V_j ,$$

where the $\bar{v}_j^V$ weights are the two-period average shares of value added in gross output. Value added in nominal terms is $P_j^V V_j = P_j^K K_j + P_j^L L_j$. The price of value added P_j^V is derived by dividing this nominal value by the quantity index from Equation (2.4).

In order to identify the impact of information technology, we isolate the industries that produce IT-related goods. In particular, we divide Electric Machinery into Computers, Electronic Components, Communications Equipment, and Other Electrical Machinery. This breakdown allows us to better identify and analyze the impact of IT-production on the Japanese economy. We derive both outputs and intermediate inputs from a time series of inter-industry transactions tables. These tables consist of a Use Table that allocates the use of each commodity among intermediate inputs and final demand categories and a Make Table that allocates the output of each commodity among the industries that produce it. The output of a given commodity by all industries and the input of this commodity by all industries must be equal.

In the Use Table the *j*th column represents industry *j* and the *i*th row represents commodity *i*. In nominal terms, the sum of the elements in column *j* is the value of the industry's output. This is equal to the value of this output to the producer, plus net indirect taxes paid on this output by the purchaser TAX_j:

$$(2.5) \quad P_j^{YT} Y_j = P_j^Y Y_j + TAX_j ,$$

where the price received by the seller is P_j^Y and the price paid by the purchaser is P_j^{YT}, which includes net indirect taxes and does not include trade and transportation margins paid by the purchaser.

An industry may produce several commodities and a commodity may be produced by several industries. The value of the output of industry *j* is equal to the value of all the commodities it produces:

$$(2.6) \quad P_j^{YT} Y_j = \sum_i M_{j,i} ,$$

where $M_{j,i}$ is the value of commodity *i* produced by *j* on Make table. This implies that:

$$(2.7) \quad P_i^{YC} Y_i^C = \sum_j M_{j,i} ,$$

where Y_i^C denotes the quantity of domestically produced commodity *i*. We assume that each commodity is an aggregate of the quantities produced in various industries and the output price of the *j*th industry P_j^{YT} is given by:

$$(2.8) \quad \ln P_j^{YT} = \sum_i \frac{M_{j,i}}{\sum_j M_{j,i}} \ln P_i^{YC} .$$

The Use Table also includes sales to final demand. This is broken down into the familiar categories of personal consumption expenditures, gross private domestic investment, government purchases, exports, and imports (*c,i,g,x,m*). The sum of the elements in row *i* of the Use Table is the value of all deliveries of the *i*th commodity to intermediate and final demand. Thus, the supply-demand balance for commodity *i* in value terms is:

$$(2.9) \quad P_i^{YC} Y_i^C = \sum_i P_i X_i + P_i (c_i + i_i + g_i + x_i) - P_i^m m_i .$$

We can rewrite this as the total supply from domestic suppliers and imports, which equals total demand:

$$(2.10) \quad P_i^{YC} Y_i^C + P_i^m m_i = \sum_i P_i X_i + P_i (c_i + i_i + g_i + x_i) .$$

We assume that all buyers purchase the same basket of commodity *i*, that is, the same share of the imported variety. The quantity of the total supply of commodity *i*, Y_i^S, is assumed to be a translog index of the two varieties, and the price is defined to make the value identity hold:

$$(2.11)\quad \begin{array}{l} \Delta \ln Y_i^S = \bar{v}_i^C \Delta \ln Y_i^C + \bar{v}_i^m \Delta \ln m_i \\ P_i Y_i^S = P_i^{YC} Y_i^C + P_i^m m_i \end{array}.$$

Note that this price P_i is the price paid by producers for their input in Equation (2.2). This completes our inter-industry accounting system.

ii. Data

We next describe the sources and methods for construction of our system of inter-industry accounts. We extend the latest version of the time-series of input-output (IO) tables in the KEO Database. This is a comprehensive productivity database for the Japanese economy produced at the Keio Economic Observatory (KEO), Keio University, Japan. The official benchmark U.S. Input-Output (IO) tables produced by the Bureau of Economic Analysis (BEA) are defined as Use Tables and transactions are classified by commodity and industry. By contrast the Japanese benchmark IO tables published by Ministry of Internal Affairs and Communications (MIC) classifies transactions commodity by commodity. The IO tables (KEO-IO) in the KEO Database consist of Commodity Table, Make Table, and Use Table. The Use Table is estimated using the other two tables, based on the commodity-technology assumption that the same input coefficients are utilized for the production of a given commodity, even if it has been produced by different industries.

The KEO-IO system has a 43-industry and 47-commodity classification, including non-competitive imports during 1960-2000.[5] The components of final demand in the KEO-IO are consistent with the corresponding components of GDP in the Japanese official national accounts. However, since the official Japanese national accounts based on 1993 SNA are estimated only back to 1980, it is impossible to estimate long-term industry accounts based on 1993 SNA. Accordingly, the latest KEO-IO was estimated on the basis of the 1968 SNA and adjusted for capitalization of custom software.

In this paper, we expand the KEO-IO in six major areas. By including capital consumption for infrastructure our estimates become close to the official Japanese national accounts. Adding capitalization of own-account and pre-packaged software, our concept approaches the 1993 SNA. Finally, additional adjustments make our accounts comparable with the U.S. accounts based on the Jorgenson system of national accounts (Fraumeni, 2000; Jorgenson and Landefeld, 2005). In 1993 SNA and also in the National Income and Product Accounts (NIPA) from the U.S. BEA, only consumption of fixed capital (CFC) is included in the production accounts for government and household sectors. The CFC is only a

[5] Although the documentation for the latest version of KEO Database estimated in 2003 is not yet published, Kuroda, Shimpo, Nomura, and Kobayashi (1997) provides a detailed explanation of the estimation of time-series Input-Output tables for the Japanese economy. The methodology for estimating the latest KEO-IO is based on the same approach.

part of the capital cost. The extension to the Jorgenson system of national accounts requires replacement of the CFC by a proper measure of capital services in non-market production. This will be considered in the next revision of SNA in 2008 (1993 SNA Revision 1) or future revisions as proposed by the Canberra II Group (Ahmad, 2004).

iii. Issues

a) Identification of IT Producers

In order to identify the impact of IT on the Japanese economy, three IT producers — Computers, Communications Equipment, and Electronic Components — are separated from Electric Machinery in the KEO-IO during 1960-2000. In the US Standard Industrial Classification (SIC), Computers (SIC-357) belong to Industrial Machinery and Equipment (SIC-35) at the two-digit level, but in Japan this industry is included in Electric Machinery. In the SIC Computers (SIC-357) consists of Electronic Computers (SIC-3571), Computer Storage Devices (SIC-3572), Computer Peripheral Equipment (SIC-3577), Calculating And Accounting Machines (SIC-3578), and Office Machines (SIC-3579). Our definition of the Computer Industry does not include SIC-3578 and 3579, both of which are included in General Machinery.[6]

The Census of Manufacturing, produced by Ministry of Economy, Trade, and Industry (METI), and the benchmark IO tables for Japan give data for production and the components of value added in the IT-producing industries. We develop a time series of data that is consistent with our industry definitions at the three-digit level, since the industry classification of the source data changes over time. We estimate the input columns of IT producers and Other Electrical Machinery using the RAS method. The sum is the same as the input column of Electric Machinery industry in the original KEO-IO. We use the values for exports and imports from the Trade Statistics of Japan by Ministry of Finance (MOF) to estimate the total domestic demand for IT commodities. Maintaining consistency with the detailed fixed capital formation matrixes estimated in Nomura (2004a, Ch.A-B), we distribute domestic demand, excluding investment, among intermediate inputs and consumption and other final demands, based on shares in Benchmark IO tables every five years. The row and column vectors aggregated from the four industries to Electric Machinery industry are unchanged from the original KEO-IO. We discuss the issue of output prices for IT producers in the next subsection.

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[6] The Computer industry in Jorgenson, Ho, and Stiroh (2005) is based on the SIC-357. In the North American Industrial Classification (NAICS), large parts of SIC-3578 and SIC-3579 are excluded from Computer and Electronic Product Manufacturing (NAICS-334) in the three-digit classification. These industries are included in Machinery Manufacturing (NAICS-333) and other industries. To be consistent with the latest NAICS data, we decided that the Computer Industry, excluding SIC-3578 and SIC-3579, is preferable in the Japanese accounts.

b) Capital Consumption of Infrastructure

Based on the 1993 SNA, capital consumption of infrastructure is included in our IO tables, although the original KEO-IO did not include it. The values of depreciation are estimated to be consistent with detailed estimates of infrastructure stock during 1955-2000 in Nomura (2004a, Ch.2). This definition increases the value added in government sector and government consumption in final demand. In the official Japanese national accounts, capital consumption of infrastructure is already treated as one component of GDP. However, it is estimated only from 1980 onwards and evaluated at historical prices. Since our estimates are in current prices and differ from the values in the official national accounts, GDP also differs. Our estimate for the additional capital consumption of infrastructure is 8.1 trillion yen in the year 2000.

c) Capitalization of Own-Account Software and Pre-packaged Software

In the Japanese national accounts, the expenditure for custom software is treated as GFCF. Although 1993 SNA also recommends the capitalizing of own-account software and pre-packaged software, the official Japanese national accounts do not follow this recommendation. In order to maintain comparability of IT impacts between the U.S. and Japan, we capitalize these two types of software. Nomura (2004b) estimates the investment and stock of own-account software by industry during 1955-2000, based on a methodology similar to the one BEA employed in the benchmark revision of the U.S. national accounts in 2003. This requires rebalancing the IO tables.[7]

Since the output of the government sector is defined by total cost, capitalization of software leads to a change in the definition of government output. The increase in the GDP is the sum of the increase of investment for own-account and pre-packaged software, the increase of consumption for both types of capital in the government sector, and the decrease of own-account software produced by the government and pre-packaged software purchased by the government. The consumption of software capital is required to be consistent with our estimates of the stock of software held by the government sector. By the capitalization of both types of software, the GDP is increased by 3.8 trillion yen in 2000 in our estimates.

d) Capital Services of Public Capital

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[7] Nomura (2004b) discusses the two different methods to describe own-account software in the IO table and achieve consistency with other data. The production of own-account software within each industry is described as an output of the software industry in our Use Table. Our labor data are not cross-classified by occupational categories. Although the labor cost for programmers and system engineers producing own-account software in each industry is deducted from the labor income, the aggregate index of wages in each industry is not be reflected in the capitalization of own-account software.

Consumption of public capital is already included in GDP in our IO table, based on the recommendation of 1993 SNA. To maintain comparability with the Jorgenson system of national accounts for the U.S., we impute the capital service costs for publicly owned capital, using the average rate of return of all industries, weighted by the nominal share of capital stock in these industries. The rate of return in each industry is defined by the weighted average of rate of interest and the rate of return on equity, as measured in Nomura (2004a, Ch.3). This is based on the methodology of Jorgenson and Yun (2001). The difference between the imputed public capital cost and CFC of public capital is defined as the operating surplus of government sector.[8] Again, this leads to a rebalancing our IO table, and an increase of GDP. Our estimate for the additional capital cost for public capital is 8.4 trillion yen in 2000.

e) Capital Services of Owner-Occupied Housing by Households

We treat households as a producer in our accounting system. One of outputs of the household sector is defined by the imputed rent for owner-occupied housing. Since the imputed rent of structures for owner-occupied housing by households is included in national accounts, this change does not affect our estimate of the GDP, although the description in our IO tables is changed accordingly.[9] Note that the output of Real Estate Industry is redefined to exclude the imputed cost of owner-occupied housing.

In 1993 SNA, land is defined as non-produced capital and income earned by renting of land is defined as property income not presented in the production account. Although the rental fees observed in the market may sometimes include the rental fees for land, the imputed rent for land is intentionally excluded from the national accounts. In the U.S., on the other hand, the imputed rent for land is included in the GDP. To maintain consistency between the national accounts in the two countries, we impute the capital cost of land for residences owned by households. The imputed value is described as the operating surplus of household sector as a producer and is added to GDP. In 2000, the increase of the GDP is 7.9 trillion yen.

f) Capital Services of Consumer Durables

In order to maintain comparability with the U.S. national accounts constructed by Jorgenson, Ho, and Stiroh (2005) we treat households as a producer. The capital services from consumer durables are defined as an output of the household sector. We estimate the stock of consumer durables for each

[8] The estimated CFC for public capital is based on the value in the national accounts. In the Japanese national accounts, CFC is defined by historical prices. The computed difference includes the capital cost, except CFC, and the revaluation of CFC from historical to current prices. In our framework, CFC and operating surplus are added to generate the cost of capital services.

[9] The imputed rent in national accounts consists of the cost of capital and also intermediate inputs. Here we estimate the capital costs from the imputed rent in national accounts. Second, we impute the rate of return for owner-occupied housing maintaining consistency with our estimates of capital cost and capital stock. The residual non-capital costs are described as intermediate inputs of the household sector in our accounts.

category of consumer durables and impute the capital service cost of the consumer durables, based on the average rate of return of all industries. The expenditures on these durables are consistent with household consumption in our IO table. This additional imputation leads to an increase of GDP. In 2000, it is 25.5 trillion yen and 4.6 percent share of our redefined GDP, based on the Jorgenson system. The share is almost half of the U.S. share, which is 9.4 percent in 2000, reflecting the larger stock of consumer durables and higher rate of return in the U.S.

iv. Output Prices for IT

International comparisons of productivity often employ internationally harmonized prices, which translate U.S. prices to comparison-country prices in order to control for the quality improvements in the comparison country.[10] These studies treat the quality-adjusted computer prices constructed by BEA as the most satisfactory for capturing the rapid technological improvements in the computer industry. Since price statistics in comparison countries often do not adjust for quality change in IT goods, the use of harmonized prices may be a useful approximation to quality-adjusted prices. However, price statistics in Japan are already quality-adjusted.

The Bank of Japan (BOJ) produces the Corporate Goods Price Index (CGPI), a system which is similar to the Producer Price Index (PPI) constructed by the U.S. Bureau of Labor Statistics (BLS). In the BOJ's 2000 benchmark revision, price statistics were vastly improved and the Wholesale Price Index (WPI) was renamed as the CGPI. Here, we refer to both sets of statistics as the WPI/CGPI. Nomura and Samuels (2004) have compared IT prices in the U.S. and Japan at the SIC three-, four-, and five-digit levels. Comparing the U.S. and Japanese price data for Personal Computers and General Purpose Computers & Servers at the five-digit level from 1995 to 2003, the gap between the two countries is not large if the index numbers are constructed by aggregation over the most detailed items available.

By adjusting the index number formula and aggregation weights for the WPI/CGPI to be consistent with the BEA's output price, the resulting price declines for Electronic Computers are comparable. During 1995-2003 prices fall 29.3 percent per year in the U.S., compared to 27.0 percent per year in Japan. At the three-digit level the price of Electronic Computers and Peripheral Equipment falls 23.8 percent per year in the U.S. compared to 15.5 percent per year in Japan. A significant portion of the price gap at the three-digit level can be explained by the Peripheral Equipment price, which falls less

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[10] Price harmonization is an attempt to control for price differences under the assumption that the comparison country's price data fails to capture quality improvements. The relative price of IT to non-IT in the comparison country is set equal to the IT to non-IT price relative in the U.S. The harmonized price is formulated such that: $\Delta \ln p_{IT}^{X} = \Delta \ln p_{nIT}^{X} + (\Delta \ln p_{IT}^{US} - \Delta \ln p_{nIT}^{US})$, where the suffix X means the reference country, p_{IT} is the IT product price, and p_{nIT} is the non-IT price.

rapidly in Japan and has a larger share of total output when exports are included. We conclude that computer prices at the SIC three-, four-, and five-digit level in the U.S. and Japan are appropriately adjusted for quality change after 1995.

During 1980-95, computer prices based on BEA data at the three-digit level fall 13.1 percent per year in the U.S., while prices fall 7.6 percent per year in Japan. In the 1980s the Japanese PC market was dominated by the NEC Corporation, which had a 60-70 percent share of domestic demand. On the other hand, the international PC market was very competitive with many manufacturers of IBM-compatible computers entering in order to combat the dominance of IBM in the early 1980s. Until 1991, the Japanese PC market was separated from the international market due to hardware and software differences and incompatibility issues, but the introduction of DOS/V as a new Operating System (OS) in 1991 changed that.

DOS/V is a version of MS-DOS that provides both English and Japanese language command interfaces and can be used for applications designed for either or both English and Japanese. DOS/V includes all the English-based commands and specific Japanese DOS/V commands.[11] Because DOS/V works on all IBM-compatible computers, foreign manufacturers were able to enter to the Japanese PC market. Competition brought prices down for computers. In 1993, NEC Corporation introduced a new model PC, priced 50 percent lower than the previous model. The import share of computers in Japan increased from 7.6 percent in 1990 to 14.3 percent in 1995 and reached to 23.1 percent in 2000.

We conclude that internationally harmonized prices for computers are inappropriate for Japan, since these prices fail to reflect differences in market conditions between Japan and the U.S. Nomura and Samuels (2004) have estimated IT prices for the Japanese economy during 1960-2003, using the available price data sources such as WPI/CGPI, Linked-IO Tables, Nikkei Data (prior to 1970), and others with the adjustment of index number formulas and aggregation weights, where possible.[12] These embody the best practice for measuring IT prices for Japan and we have used them in this paper.

III. Measuring Capital Input

i. Methodology

This section outlines our methodology for measuring the flow of capital services in each industry. The key objective is to account for substitution among assets with different marginal products. The

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[11] DOS/V gets its name because it requires a Video Graphics Array (VGA) display. In 1991 the Open Access Development Group (OADG), a consortium organized by IBM, developed DOS/V.

[12] Nikkei Data is a time series data covering real and nominal output, imports, and exports, based on the commodity classification in the Japanese benchmark 1965 IO table. Output data covers 1951 to 1968 and import and export data cover 1951 to 1972. These data was constructed at the Japan Center for Economic Research (JCER), directed by Professor Iwao Ozaki, Keio University. Unfortunately, the documentation for these data is no longer available.

methodology was originated by Jorgenson and Griliches (1995), who constructed price and quantity indexes for capital input, based on Jorgenson's (1996) model of the corporate cost of capital. These indexes were extended to the industry level for all three legal forms of organization – corporate, non-corporate, and household - by Jorgenson, Gollop, and Fraumeni (1987, Ch.4) and updated and revised by Jorgenson (1995). We are unable to identify corporate and non-corporate capital services separately for Japan because of data constraints.

Jorgenson, Ho, and Stiroh (2005) incorporate recent methodological advances by Jorgenson and Stiroh (2000). These include the use of asset-specific revaluation terms in the service price equation. In addition, capital service flows from new investments are assumed to become available in the middle of the year, rather than at the end of the year, as in earlier work. In the measurement of capital in Japan Nomura (1998) used asset-specific revaluation terms and Nomura (2004a, Ch.3) changed the timing of capital service flows from new investments to be consistent with Jorgenson and Stiroh (2000), except for buildings and structures.

We begin with notation for investment, capital stocks, and capital services for individual assets and industry aggregates. The subscript *k* refers to the specific asset, while *j* refers to the industry; time subscripts are suppressed wherever possible. For individual assets we have:

$A_{k,j}$	quantity of investment
$S_{k,j}$	quantity of capital stock
$Z_{k,j}$	quantity of installed capital stock
$K_{k,j}$	quantity of capital service
P_k^A	price of investment, which is the same as price of capital stock for each *k*
$P_{k,j}^K$	price of capital service
$V_{k,j}^K$	nominal capital service cost
δ_k	geometric depreciation rate

For industry aggregates:

A_j	quantity index of industry investment
Z_j	quantity index of industry installed capital stock
K_k	quantity index of industry capital service
P_j^A	price index of industry investment

P_j^Z price index of industry stock

P_j^K price index of industry capital service

Q_j^K index of industry capital quality

For each industry we begin with data on the quantity of investment in each individual asset $A_{k,j}$. We assume that the investment price index transforms nominal investment in different time periods into identical "efficiency units" over time, so that investments of different vintages are perfect substitutes in production. Improvements in the performance of capital input, for example, a faster processor in a computer, are incorporated into the price index that transforms the current vintage of investment into an equivalent number of efficiency units of earlier vintages. As a concrete example, the constant-quality price index for computer equipment transforms more recent investments in faster, more powerful, computers into additional units of constant efficiency base-year computers.

We transform data on the quantities of investment into estimates of capital stocks for all assets, industries, and years through the familiar perpetual inventory method. This is consistent with the assumption of perfect substitutability across vintages and defines the capital stock for each industry and asset as:

$$(3.1) \qquad S_{k,j,t} = S_{k,j,t-1}(1-\delta_k) + A_{k,j,t} = \sum_{\tau=0}^{\infty}(1-\delta_k)^{\tau} A_{k,j,t-\tau} ,$$

where the efficiency of an asset is assumed to decline geometrically with age at the rate δ_k. The geometric approach makes it possible to simplify the perpetual inventory method, as in Equation (3.1).

Equation (3.1) has the interpretation that capital stock is a weighted sum of past investments, where the weights are derived from the relative efficiencies of capital of different ages, captured by the geometric rate of decline. Note that the rates of decline in efficiency δ_k are indexed by asset only and not by industry. Finally, because all capital is measured in base-year efficiency units, the appropriate price for valuing the capital stock is the investment price deflator P_k^A.

Since investment $A_{k,j}$ is defined in terms of progress in construction, the capital stock $S_{k,j}$ defined in Equation (3.1) includes capital goods that are not yet installed. For each asset we assume that new investment becomes available for production at the mid-point of the year so the installed capital stock for each industry and each asset is assumed to the arithmetic average of the current and lagged capital stock. An exception to this, considering the time lag between progress in construction and installation, is that we assume the installed stock of buildings and structures is the lagged capital stock:

$$(3.2) \qquad Z_{k,j,t} = \begin{cases} S_{k,j,t-1} & k \in Buildings, Structures \\ \left(S_{k,j,t} + S_{k,j,t-1}\right)/2 & otherwise \end{cases} .$$

The installed stock of capital $Z_{k,j}$ represents the accumulation of past investments, but we are primarily interested in $K_{k,j}$, the flow of capital services from that stock over a given period. This distinction is not critical for individual assets, but becomes essential when we aggregate heterogeneous assets to form an industry or economy-wide aggregate. We assume the flow of capital services for each industry and each asset is proportional to the installed stock of capital:

$$(3.3) \qquad K_{k,j,t} = \phi_{k,j} Z_{k,j,t} ,$$

where $\phi_{k,j}$ denotes the proportionality constant. The constant coefficient: $\phi_{k,j}$, is an "annualization factor", which transform capital stock into capital services. Here, we normalize it to one; therefore, the stock and services of capital are identical: $K_{k,j} = Z_{k,j}$.

We estimate a price of capital services that corresponds to the quantity of capital input via the cost-of-capital formula. With no uncertainty about capital income, investors are indifferent between earning a nominal rate of return i_t on a different investment or buying a unit of capital, collecting a rental fee, and then selling the depreciated asset in the next period. For investors purchasing the asset the cost of capital equals the marginal product of the asset. This implies the familiar cost of capital, or user cost, for each asset in each industry:

$$(3.4) \qquad P^K_{k,j,t} = (i_{j,t} - \pi_{k,t}) P^A_{k,t-1} + \delta_k P^A_{k,t} ,$$

where the asset-specific capital gains term is $\pi_{k.t} = (P^A_{k,t} - P^A_{k,t-1}) / P^A_{k,t-1}$ and $i_{j,t}$ is the nominal rate of return in industry j.

The cost of capital accounts for the nominal rate of return, asset-specific depreciation, and asset-specific revaluation. An asset with a higher depreciation rate has a higher marginal product and must receive a higher capital service price as compensation. Similarly, if an investor expects a capital loss ($\pi_{k,t} < 0$), then a higher service price is required. Jorgenson and Stiroh (2000) and Oliner and Sichel (2000) discuss the importance of incorporating asset-specific revaluation terms for information technology assets experiencing rapid downward revaluations.

Tax considerations are also a key component of capital service prices, as discussed by Hall and Jorgenson (1996) and developed in detail by Jorgenson and Yun (2001) for the U.S. economy and Nomura (1998, 2004a) for the Japanese economy. We follow Nomura (2004a, Ch.3) in accounting for capital consumption allowances, income allowances and reserves, special depreciation, corporate income tax, business income tax, property taxes, acquisition taxes, debt/equity financing, and personal taxes. We estimate an asset-specific, after-tax real rate of return for each asset in each industry, $r_{k,j,t}$, that enters the cost-of-capital formula:

$$(3.5)\qquad P^K_{k,j,t} = \frac{1+(1-\tau_t)\tau^A_{k,t} - \tau_t z_{k,t}}{1-\tau_t}\left[r_{k,j,t}P^A_{k,t-1} + \delta_k P^A_{k,t}\right] + \tau^P_{k,t}P^A_{k,t},$$

where τ_t is the rate for corporate income tax and business income tax, $z_{k,t}$ is the present value of capital consumption allowances for tax purposes, $\tau^A_{k,t}$ is a acquisition tax rate, $\tau^P_{k,t}$ is a property tax rate.[13] The rate of return $r_{k,j,t}$ is formulated as a weighted average of real, after-tax returns to debt and equity. We then assume the after-tax rate of return to all assets in each industry is the same and exhaust the value of payments to capital across all assets in the corporate sector of each industry. Inventories and land have a depreciation rate of zero and do not qualify for capital consumption allowances for tax purposes, so the cost-of-capital formula in Equation (3.5) can be simplified for these assets.

Equations (3.1) through (3.5) describe our estimation procedure for the capital service flows and capital service prices, $K_{k,j}$ and $P^K_{k,j}$, respectively, for each asset, industry, and time period. We combine capital services for all assets within an industry by means of a translog quantity index as:

$$(3.6)\qquad \Delta \ln K_j = \sum_k \bar{v}^K_{k,j} \Delta \ln K_{k,j}$$

where the $\bar{v}^K_{k,j}$ weights are the two-period average shares of each type of capital income in total capital income by each industry. The corresponding price index of capital inputs P^K_j is defined implicitly to make the value identity hold:

$$(3.7)\qquad V^K_j = P^K_j K_j = \sum_k P^K_{k,j} K_{k,j} = \sum_k V^K_{k,j}\ .$$

Similarly, the price index for capital stock P^Z_j is defined implicitly by the identity:

$$(3.8)\qquad P^Z_j Z_j = \sum_k P^A_{k,j} Z_{k,j}\ .$$

We define capital quality Q^K_j for industry *j*, as the ratio of capital input to capital stock:

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[13] The cost-of-capital formula is summarized here for simplicity. Nomura (2004a, Ch.3) develops a detailed cost-of-capital formula based on the Japanese tax structure. In the Japanese tax system, a business income tax is levied on revenue for some industries like electricity, although Equation (3.4) does not identify the differences. Since the use of income allowances and reserves could reduce the effective tax rate for corporate income, a denominator of the formula, $(1-\tau_t)$, depends on the rate of return. Also, $z_{k,t}$ depends on the imputed rate of return, although Jorgenson and Yun (2001) treat this as exogenous.

$$(3.9) \quad Q_j^K = \frac{K_j}{Z_j} ,$$

where:

$$(3.10) \quad Z_j = \sum_k Z_{k,j}$$

is the unweighted sum of each type of capital stock.[14]

The translog index of capital input in the Equation (3.6) is a discrete approximation to the Divisia index; $\left(\dot{K}_j / K_j\right) = \sum_k v_{k,j}^K \left(\dot{K}_{k,j} / K_{k,j}\right)$ defined in a continuous time, where $v_{k,j}^K$ are nominal shares of each type of capital income in total capital income. In comparison to the Divisia index of capital inputs, the growth rate of capital stock in the Equation (3.10) is interpreted the weighted average of the growth rates of capital stock by each asset; $\left(\dot{Z}_j / Z_j\right) = \sum_k w_{k,j}^Z \left(\dot{Z}_{k,j} / Z_{k,j}\right)$, where the weights $w_{k,j}^Z$ are the shares of each type of capital in total capital stock. The difference of two indexes, $\left(\dot{K}_j / K_j\right) - \left(\dot{Z}_j / Z_j\right)$, is the growth rate of capital quality in Equation (3.9). Since the growth rates of capital inputs and capital stocks are the same for each asset, the difference is the use of capital service costs versus capital stocks as weights; $\left(v_{k,j}^K - w_{k,j}^Z\right) = v_{k,j}^K \left(1 - \widetilde{P}_j^K / P_{kj}^K\right)$, where $\widetilde{P}_j^K$ is an average capital service price defined by $V_j^K / Z_j \left(= V_j^K / \sum_k K_{kj}\right)$. This implies that growth in capital quality reflects substitution towards assets with relatively high service prices and high marginal products. For example, large depreciation rates and rapid downward revaluations for computers imply that these assets have high marginal products, so that their weights will be positive. The higher weights for computers imply that the substitution toward computers makes capital input grow faster. This is captured by our index of capital quality.

Finally, we separate IT capital and Non-IT capital. The capital services of IT assets K_j^{IT} include the service flows from computer hardware, software, and communications equipment, while the Non-IT capital service flow K_j^{nIT} includes the services from all other equipment, structures, inventories, and land. We create sub-indexes of capital services as:

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[14] Jorgenson, Ho, and Stiroh (2005) define capital quality by the ratio of the translog index of capital inputs over the translog index of capital stock. In this paper, we define the capital quality using the simple sum of capital stock as a denominator, analogously with the definition of labor quality. Nomura (2004a, Ch.4) examines both indexes for capital quality, the growth of capital quality using the simple sum of capital stock is higher than that with the translog index of capital stock during 1960-2000 for the Japanese economy.

$$\Delta \ln K_j^{IT} = \sum_{k \in IT} \bar{v}_{k,j}^{IT} \Delta \ln K_{k,j}^{IT}$$

(3.11)

$$\Delta \ln K_j^{nIT} = \sum_{k \notin IT} \bar{v}_{k,j}^{nIT} \Delta \ln K_{k,j}^{nIT},$$

where the shares, $\bar{v}_{k,j}^{IT}$ and $\bar{v}_{k,j}^{nIT}$, are those of IT capital and Non-IT capital, respectively.

ii. Data

Gross Capital Stock Private Enterprises (GCSPE), produced by Economic and Social Research Institution (ESRI) of the Cabinet Office (CAO), is the main data source for the Japanese capital stock by industry. However, the GCSPE is defined as gross capital stock and does not have an asset classification; using this estimate of productive capital stock would result in biases. Nomura (2004a, Ch.2) shows that the stock estimates of GCSPE may have an upward bias of 20 percent in 2000. This is due to the use of the gross concept and the absence of consideration of quality change for heterogeneous capital. We conclude that the official stock data are not sufficiently precise for our purposes.

Our investment data are based on the estimates of Nomura (2004a, Ch.A-B). He estimates a time series of private and public fixed capital formation matrixes by 46 industries and 95 fixed assets during 1955-2000. The data sources are the benchmark Fixed Capital Formation Matrixes (IO-FCFM), which are published by the MIC every five years after 1970 as one of supplementary tables of benchmark IO tables, the Annual Report of Financial Statements of Corporations produced by the Ministry of Finance (MOF), and many other primary data sources for investment, production, and trade in capital goods.[15] We estimate stock matrixes for fixed assets, based on the best geometric approach for each fixed asset and a perpetual inventory method, using the initial benchmark stock of the Japanese National Wealth Survey in 1955.

The stocks of inventories and land by industry are estimated in the Chapters C and D in Nomura (2004a), respectively. In the Japanese economy, the value of land is particularly noteworthy. By comparison with the 23.6 percent share of land in nominal capital stock in the U.S. in 2000, the Japanese land share is 43.5 percent in 2000, even though the Japanese economy has experienced a record decline of land prices in the 1990s. Diewert and Lawrence (2000) indicate that neglecting land and inventories leads to a decline in average TFP growth rates of 0.1 percent per year in Canada. This is large in relative terms, since the average growth rate for the Canadian TFP averaged only 0.5-0.6 percent per year during 1963-1996.

Nomura (2004a, Ch.4) shows that neglecting land and inventories for Japan leads to a decline of 0.7 percent per year in the average TFP growth rate during 1960-2000, compared to 1.5 percent annual

[15] The latest 2000 IO-FCFM became available after Nomura (2004a) was published. We have revised our capital matrixes to incorporate the latest IO-FCFM.

average growth rate for Japanese TFP. TFP growth is underestimated by a factor of almost fifty percent if land and inventories are ignored! Land has a significant role in the measurement of capital and productivity, especially in Japan. The clarification of the role of land as a capital input in production account is one of the most significant aspects of Jorgenson system of national accounts. Probably due to the definition of land as a non-produced capital input in the 1993 SNA, the cost of land has been neglected in production analysis. The capital cost of land, however, is implicitly included in value added in the production account. In addition, our accounting system in this paper is defined to include the capital cost of land also for non-market production as well.

iii. Issues

Although the methodology described above conforms to the international standards recommended by Blades (2001) and Schreyer (2001) of the OECD, there are important issues related to the availability of data and the plausibility of certain assumptions that arise in implementing this methodology. This subsection outlines these issues and presents our solutions.

g) Negative Service Prices

The intuition behind our estimation of capital service prices is that the value of capital service flows must exhaust capital income. One problem is that there is very little income, or exceptionally large negative capital income, in the periods of the oil shocks. This leads to negative estimates of service prices. For example, if asset inflation rates are high and depreciation rates are low, relative to the weighted average rate of return, negative service prices may result. This occurs especially in measuring capital service prices for land during the period of the Japanese bubble economy in the late of 1980s, since land is a non-depreciable asset. Economically, this is possible and suggests that ex post capital gains are higher than expected, so that a small service price is possible in equilibrium. Empirically, however, negative service prices make aggregation difficult so we have made adjustments for several assets. To avoid the negative capital service prices, Jorgenson, Ho, and Stiroh (2005) and Nomura (1998) use a smoothed inflation rate from the surrounding years rather than current inflation in the cost-of-capital calculation. Berndt and Fuss (1986) and Diewert (2005) discuss this issue in more detail.

Bulow and Summers (1984) distinguish the "income risk", which refers to uncertainty in future capital incomes, and "capital risk", which refers to uncertainty in future asset prices. In our framework of measuring capital, although no income risk is assumed, Nomura (2004a, Ch-3) considers the difference of capital risks among different assets to avoid negative capital service prices generated by ex post high capital gains. The difference of risk premium of asset k from the risk premium of average asset in industry j is assumed to be:

$$(3.12) \quad R_{k,j} = \frac{\sigma_k^{\pi}}{\sigma_j^{\pi}} \left(\pi_k - \pi_j\right),$$

where σ_k^{π} is a standard deviation of the price change π_k and σ_j^{π} is a standard deviation of π_j, which is the price change of average asset, defined later. In the Equation (3.12), price changes in assets are regarded as surrogates for the rate of return on each asset.[16] If it is assumed that there is no uncertainty about the price change of asset *k*, $\sigma_k^{\pi} = 0$, and the risk premium for asset *k* is zero. Since the imputed rate of return on equity includes the average risk premium for asset price uncertainty, the average of risk premiums in each industry is assumed to be zero. If the price change of asset *k* is expected to be the same as the price change of average asset in *j* industry: $\pi_k = \pi_j$, the risk premium for asset *k* is also zero.

To set the average of risk premium in any industry to zero, we assume π_j is

$$(3.13) \quad \pi_j = \frac{\sum_k \pi_k \sigma_k^{\pi} v_{k,j}^Z}{\sum_k \sigma_k^{\pi} v_{k,j}^Z},$$

where $v_{k,j}^Z$ is a nominal share of asset *k* in industry *j*. Assuming that the weighted average of differences in risk premia among assets is zero in each industry: $\sum_k v_{k,j}^Z R_{k,j} = 0$. If the price variation of an asset is relatively high and the capital gain is over that of the average asset, $R_{k,j}$ is positive for the asset. The rate of return $r_{k,j}$ in the Equation (3.5) is assumed to be $r_{k,j} + R_{k,j}$. Considering the difference of capital risks among assets can reduce the likelihood of negative capital service prices. As a last resort, we interpolate the negative measured capital service prices, using the average price for capital services of all assets.

h) Capitalization of Software

As described in the previous section, the expenditures for own-account and pre-packaged software are not capitalized in the official Japanese national accounts. We capitalize both types of software in our accounts, based on the estimates in Nomura (2004b). Relative to the official GDP, redefined to include the investment in three types of software, the share of total software investment is 2.03 percent in 2000, which is almost the same as the U.S. share of 2.07 percent. Including three types of software, our capital stock matrixes consist of 102 assets: three types of inventory, four types of land, 90 tangible assets, and five intangible assets. These assets are listed in Table 1.

i) Capital for IT-Producing Industries

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[16] Although it is possible to consider different formulations for capital risk, we assume that the set of Equations (3.12)

We are particularly interested in IT-producing industries, but Nomura (2004a) provides insufficient detail. We estimate investment of Computers, Communications Equipment, and Electronic Components industries using two main data sources. The IO-FCFM gives the asset composition of investment every five years from 1970 to 2000. The Census of Manufacturing produced by the Ministry of Economy, Trade, and Industry (METI) gives annual data for acquisition of two types of assets and the possession of land and inventories for the IT-producing industries. Maintaining consistency with capital formation matrixes estimated in Nomura (2004a), we expand our fixed capital formation and stock matrixes during 1955-2000 to include the IT-producing industries.

j) Infrastructure as a Sector Holds Capital

One of the most substantial differences between the U.S. capital data described in Jorgenson, Ho, and Stiroh (2005) and Japanese capital data is the treatment of infrastructure as a sector. In Japan, infrastructure sectors are identified separately from other government activities. Nomura (2004a)'s capital matrix has 23 classes of infrastructure investment. By expanding to IT-producing industries, our capital matrixes have 70 capital-holding sectors in total; 45 industries, general government, excluding other identified infrastructure, and households, which hold housing and consumer durables. Identification in government-owned capital makes it possible to compute CFC and the service cost of government capital as precisely as possible.

k) Deflators for IT capital assets

Jorgenson and Stiroh (2000) argued that the official deflators, especially for software and communications equipment, do not fully account for quality change. In the U.S. the price index for own-account software was defined by the BEA's input cost index, consisting of labor compensation cost indexes and an intermediate inputs cost index. For custom software, the price index was defined as a weighted average of the price indexes for own-account software and pre-packaged software, where the weights are arbitrarily selected as 75 percent for own-account software and 25 percent for pre-packaged software (Parker and Grimm, 2000). In the 2003 revision by the BEA, both price indexes for custom software and own-account software are defined by a weighted average of the input cost index with the NIPA pre-packaged software price index, which is estimated holding the quality constant.[17]

In Japan, a satisfactory estimate of the constant-quality price for pre-packaged software is not available.[18] The price for custom software estimated by the BOJ after 1995 from the Corporate Service Price Index (CSPI), is based on labor cost. The official Japanese national accounts also use this price

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and (3.13) holds.

[17] See Grimm, Moulton, and Wasshausen (2005).

[18] BOJ began to estimate the price for pre-packaged software in their CSPI after 2000, although it is based on the cost evaluation method.

index and extend it backward to 1980. Nomura (2004b) extends this cost index backward to 1955, based on a similar method. In Japan, the share of pre-packaged software in total software investment is slightly less than 6.2 percent in 2000, based on Nomura (2004b), by comparison with 28.0 percent in the U.S. We use same deflator as that of the Japanese national accounts for the three kinds of software.[19]

For IT capital goods, computers and communications equipment, we use the investment prices estimated in Nomura and Samuels (2004). These price indexes are based on import shares and import prices, trade margins, transportation costs, and the "best practice" output prices mentioned in the previous section. The rates of decline in the IT investment prices are smaller than in the IT output prices, reflecting the more moderate movements in prices for wholesale trade and transportation.

l) Depreciation Rates

Many studies of the Japanese economy use the depreciation rates of the BEA (Fraumeni, 1997). However, depreciation rates can differ between the U.S. and Japan, reflecting differences in natural and environmental conditions, as well as utilization, maintenance, and composition of capital goods. Nomura (2004a, Ch-2) estimates depreciation rates based on a Box-Cox transformed age-price profile, using data in the second-hand market for motor vehicles, and an age-efficiency profile using data in the rental markets for housing in Japan. The geometric approach is accepted as an approximation for these assets.

The estimated geometric depreciation rates are 16.3 percent for passenger motor vehicles, 22.4-23.8 percent for trucks, and 3.1-4.8 percent for housing. By comparison with the U.S. depreciation rates in the BEA, passenger vehicles and housing are less durable and trucks are more durable in Japan. In this paper we use these estimates. For other assets, we estimate average service lives T based on the Japanese tax-lives and the arbitrary rates converted to effective service-life in each fixed asset. Based on the relationship: $\delta = R/T$, we compute the Japanese depreciation rates using the declining balance rates R originated by Hulten-Wykoff (1981) and employed by the BEA.

The BEA depreciation rates currently incorporate Oliner's (1993, 1994) estimates for all computer components except personal computers. Jorgenson, Ho, and Stiroh (2005) use 31.5 percent for computers based on the depreciation schedule of the BEA. In Japan, the tax-life is four years for personal computers and five years for other computers, which are abridged from six years after the 2001 fiscal year. Based on the tax lives, we assume 34.7 percent depreciation rate for computers in Japan. The depreciation rates for all assets in this paper are presented in Table 1.

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[19] In order to check the sensitivity of the change of software prices, Nomura (2004b) estimates a harmonized price index for pre-packaged software, based on the cost indexes in the U.S. and Japan and the NIPA pre-packaged software price index. When the BEA definition of prices for own-account software and custom software is applied, the growth rate of total software stock in Japan is 8.3 percent during 1995-2000, by comparison with 6.3 percent for

III. Measuring Labor Input

i. Methodology

Our methodology for deriving labor input was introduced by Jorgenson and Griliches (1995), who constructed an index number of aggregate labor input, based on labor compensation data for male workers, classified by educational attainment. This was extended to the industry level for the U.S. economy by Jorgenson, Gollop, and Fraumeni (1987, Ch.3). and greatly disaggregated by age, sex, occupation, class of employment, as well as educational attainment. In this section we describe the construction of labor input indexes by industry for Japan.

To construct a measure of labor input that accounts for heterogeneity in hours worked, we now describe our implementation, beginning with the notation.

saecj	subscripts for sex, age, education, class, industry
E_{saecj}	employment matrix, number of workers in cell s,a,e,c,j
H_{saecj}	hours worked by all workers in cell s,a,e,c,j
$H_{l,j}$	abbreviation for H_{saecj}
$L_{l,j}$	labor input of cell *l* in industry j
$P^L_{l,j}$	price of labor input of cell *l*
$V^L_{l,j}$	nominal labor cost of cell *l*

We express the industry volume of labor input as a translog quantity index of the individual components:

$$(4.1) \qquad \Delta \ln L_j = \sum_l \bar{v}^L_{l,j} \Delta \ln L_{l,j} ,$$

where the $\bar{v}^L_{l,j}$ weights are the two-period average share of each type of labor income in total labor income by each industry. To quantify the impact of substitution among different types of labor input, we assume that labor input for each category $L_{l,j}$ is proportional to hours worked $H_{l,j}$:

$$(4.2) \qquad L_{l,j} = \varphi_{l,j} H_{l,j} ,$$

the prices defined by the cost index. Although our estimates may understate the growth of capital inputs and outputs as final demands of software, we have chosen to employ the cost index.

where the constants of proportionality $\varphi_{l,j}$ transform hours worked into flows of labor services. We assume that labor services are the same at all points of time for each category of hours worked. For example, an hour worked by a self-employed male worker, aged 34, with four years of college education, represents the same labor input in 1977 as in 2000.

Under assumption Equation (4.2) the labor quantity index in Equation (4.1) is expressed in terms of hours worked:

$$(4.3) \qquad \Delta \ln L_j = \sum_l \bar{v}_{l,j}^L \Delta \ln H_{l,j} \,.$$

Observations on the constants $\varphi_{l,j}$ are not required to define aggregate labor input. The corresponding price of labor input P_j^L is the ratio of the value of labor compensation to the volume index. The total value is simply:

$$(4.4) \qquad V_j^L = P_j^L L_j = \sum_l P_{l,j}^L L_{l,j} = \sum_l V_{l,j}^L \,.$$

Finally, the labor quality index measures the contribution of substitution among the components of labor input to the volume obtained from a given number of hours:

$$(4.5) \qquad Q_j^L = \frac{L_j}{H_j} \,,$$

where:

$$(4.6) \qquad H_j = \sum_l H_{l,j}$$

is the unweighted sum of each type of hours worked. The definition of labor quality in Equation (4.5) is similar to the definition of capital quality in Equation (3.9).

ii. Data

We use the labor data in the KEO Database, described in Kuroda, Shimpo, Nomura, and Kobayashi (1997, Ch.4) for the period 1960-1992, and extend these data to 2000. The KEO Database classifies workers by sex, age (eleven classes), educational attainment (four classes for males, three classes for females), employment class (three types: employees, self-employed, and unpaid family workers), and industry.[20] There is a total of (11 x 4 x 3) +(11 x 3 x 3) = 231 types of workers for each of 43 industries: in total 231*43=9,933 cells.

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[20] The age classes consist of 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-. Classes of education attainment are 1) less than high school degree, 2) high school degree, 3) professional school, and 4) college degree and above for males, and 1), 2), and 3)+4) for females. Before 1980, the education attainment of females is split into just two classes: 1) and 2)+3)+4). Those attending but not completing universities are in 2).

The data source for estimating the employment matrix is the Population Census of Japan, Statistics Bureau, MIC, for benchmark years in every five years from 1960 to 2000.[21] The Labour Force Survey (LFS) by MIC, Census of Manufacturing by METI, and many other primary data sources are used to interpolate between the benchmark years. Although a multiple jobholder is counted as one in the Population Census, the Employed Persons Employees and Hours Worked classified by Economic Activities, a supporting table in the Japanese National Accounts, counts the workers in multiple jobs. Our estimated employment matrix is converted to this concept.

The Basic Survey on Wage Structure, Ministry of Health, Labour and Welfare (MHLW), is the data source for estimating average hours and wages for employees. To complement the information for some industries and categories, the Monthly Labour Survey by MHLW, the Census of Manufacturing, the LFS, and some other primary data are used. For self-employed and unpaid family workers, the LFS gives average hours. Wage rates of self-employed and unpaid family workers are imputed from data available for select industries to yield an estimate of labor compensation for the self-employed group. The wage differential between the self-employed and unpaid family workers is estimated to be the same as the differential between full-time and part-time employees.[22]

Total labor compensation by industry has to be consistent with the input-output table. The adjustment coefficients are computed from the discrepancy between the labor data and the KDB-IO. We maintain consistency at the industry level by adjusting average hours worked. The KEO Database does not have labor input for the separate industry categories for IT producers. In this paper, we estimate the average wages for IT-producing industries, based on the Census of Manufacturing. We estimate time-series wage indexes p_j^L for three IT-producing industries and Other Electric Machinery during 1960-2000. The labor quality indexes for the four industries are assumed to be identical.

IV. Measuring Industry Productivity

i. Methodology

We next examine the sources of Japanese economic growth at the industry level. The contributions of capital and labor inputs and gains in aggregate total factor productivity ultimately reflect the evolution of the production structure at the industry level and it is critical to examine the component industries. Changes in this production structure cumulate into the determinants of economic growth as technologies evolve and prices and economic incentives are altered accordingly.

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[21] The Population Census is available every five years, except 1945, from 1920.

Our methodology for measuring total factor productivity at the industry level begins with an industry production function:

$$(5.1) \qquad Y_j = f(K_j, L_j, X_j, T_j),$$

where Y_j is industry output[23], K_j is capital input, L_j is labor input, and X_j is intermediate input, and T_j as an indicator of efficiency, all for industry *j*. The variables K_j, L_j, and X_j are each aggregates of the many components described in the preceding sections and the production function Equation (5.1) is assumed to be separable in these components, based on the Leontief-Sono aggregation theorem.

Let P_j^Y, P_j^K, P_j^L, and P_j^X denote the prices for outputs and the three inputs, respectively. Under the assumptions of constant returns to scale and competitive markets, a translog index of total factor productivity (TFP) growth is defined as:

$$(5.2) \qquad v_{T,j} \equiv \Delta \ln Y_j - \bar{v}_j^K \Delta \ln K_j - \bar{v}_j^L \Delta \ln L_j - \bar{v}_j^X \Delta \ln X_j,$$

where $\bar{v}_j^i \left(i \in K, L, X\right)$ is the two-period average share of the input in the value of output. Note that the value of output is equal to the sum of outlays on all inputs, so that $P_j^Y Y_j = P_j^K K_j + P_j^L L_j + P_j^X X_j$ and the value shares sum to one.[24]

Equation (2.4) provides an alternative definition in terms of value added:

$$(5.3) \qquad v_{T,j} \equiv \bar{v}_j^V \Delta \ln V_j - \bar{v}_j^K \Delta \ln K_j - \bar{v}_j^L \Delta \ln L_j.$$

While useful for aggregation purposes, this definition fails to identify the role of intermediate inputs, such as semiconductors used in producing computers and communications equipment. The definition of industry-level total factor productivity growth in Equation (5.2) is more useful for this purpose and will be employed in our study of the growth of individual industries.

Under the same assumptions as in Equation (5.2), we decompose industry labor productivity growth, or growth of output per hour worked, as:

$$(5.4) \qquad \Delta \ln y_j = \bar{v}_j^K \Delta \ln k_j + \bar{v}_j^L \Delta \ln Q_j^L + \bar{v}_j^X \Delta \ln x_j + v_{T,j},$$

where lower-case letters refer to output and inputs per hour worked. The terms on the right-hand side are the contributions of capital deepening, labor quality, intermediate input deepening, and TFP growth to

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[22] Jorgenson, Ho, and Stiroh (2005) assume that the hourly wage of the self-employed and unpaid family workers equals the hourly wage of the employed. Estimates of hours worked, multiplied by the wage for the same category of employed worker, yields an estimate of labor compensation for the self-employed and unpaid family workers.

[23] We refer to this simply as "output" although the term "gross output" is sometimes used to distinguish this measure from "value added".

[24] See Hall (1988), Basu and Fernald (1995, 1997), and Basu, Fernald, and Shapiro (2001) for alternative assumptions and their implications.

growth of labor productivity, respectively. We refer to Equation (5.2) as TFP growth or productivity growth, and Equation (5.4) as average labor productivity (ALP) growth.

V. Aggregation Over Industries

i. Methodology

To examine the Japanese economy as a whole, we next aggregate across industries. We define the production possibility frontier as the efficient combination of outputs and inputs for the economy as a whole. Value added, *V*, consists of value added from all *j* industries and is produced from primary inputs and technology as:

$$(6.1) \qquad V(V_1,...V_J) = f(K, L, T),$$

where *V*, *K*, and *L* are aggregate value added, capital services, and labor input, respectively.

The production possibility frontier does not impose the assumption of perfect substitution of value added between industries required for the existence of an aggregate production function. We define value added as a translog index over industry value added:

$$(6.2) \qquad \Delta \ln V = \sum_j \overline{w}_j^V \Delta \ln V_j ,$$

where $\overline{w}_j^V$ is the two-period average share of industry value added in aggregate value added and V_j is from Equation (2.4).

Aggregate capital and labor inputs are defined as translog indexes of all types of capital and labor, respectively:

$$(6.3) \qquad \begin{aligned} \Delta \ln K &= \sum_{k,j} \overline{w}_{k,j}^K \Delta \ln K_{k,j} \\ \Delta \ln L &= \sum_{l,j} \overline{w}_{l,j}^L \Delta \ln L_{l,j} \end{aligned} ,$$

where the weights, $\overline{w}_{k,j}^K$ and $\overline{w}_{l,j}^L$, are the two-period average share of each type and each industry of capital or labor input in total capital or labor input. P^V, P^K, and P^L are the corresponding price indexes for aggregate value added, capital, and labor, respectively, to make the value identity $P^V V = P^K K + P^L L$.

We define aggregate quality indexes for capital and labor:

$$(6.4) \qquad Q^K = \frac{K}{Z}, Q^L = \frac{L}{H},$$

where $Z = \sum_{k,j} Z_{k,j}$ and $H = \sum_{l,j} H_{l,j}$. The quality indexes of capital and labor, defined by industry in Equation (3.9) and (4.5), respectively, represent the composition of capital and labor inputs within each industry. Next, we define the quality indexes for reallocation of capital and labor inputs by industry:

$$Q_k^{KA} = \frac{K_k}{Z_k}, Q_l^{LA} = \frac{L_l}{H_l},$$

where $Z_k = \sum_j Z_{k,j}$ and $H_l = \sum_j H_{l,j}$. K_k and L_l are the translog quantity indexes of capital and labor, defined by $\Delta \ln K_k = \sum_j \overline{w}_{j,k}^K \Delta \ln K_{k,j}$ and $\Delta \ln L_l = \sum_j \overline{w}_{j,l}^L \Delta \ln L_{l,j}$.

The growth of aggregate capital and labor inputs in Equation (6.3) can be rewritten using the quality indexes,

$$(6.5) \qquad \begin{aligned} \Delta \ln K &= \Delta \ln Z + \Delta \ln Q^K = \Delta \ln Z + \Delta \ln Q^{KI} + \Delta \ln Q^{KA} + \Delta \ln Q^{KO} \\ \Delta \ln L &= \Delta \ln H + \Delta \ln Q^L = \Delta \ln H + \Delta \ln Q^{LI} + \Delta \ln Q^{LA} + \Delta \ln Q^{LO} \end{aligned},$$

where:

$$(6.6) \qquad \begin{aligned} Q^{KI} &= \sum_j \overline{w}_j^K Q_j^K, Q^{LI} = \sum_j \overline{w}_j^L Q_j^L \\ Q^{KA} &= \sum_k \overline{w}_k^K Q_k^{KA}, Q^{LA} = \sum_l \overline{w}_l^L Q_l^{LA} \end{aligned}.$$

where Q^{KI} and Q^{LI} are aggregate measures for quality of capital and labor, defined in Equation (3.9) and Equation (4.5), respectively. Also, Q^{KA} and Q^{LA} are aggregate measures for reallocation of capital and labor among industries defined in Equations (6.5) for each category of capital and labor. Total quality indexes for capital and labor are the sums of Q^{iI}, Q^{iA}, and Q^{iO} ($i \in K, L$), which are cross-effects by industry and category and defined as the residuals in Equation (6.6).

We then define aggregate TFP growth as:

$$(6.7) \qquad v_T \equiv \Delta \ln V - \overline{v}^K \Delta \ln K - \overline{v}^L \Delta \ln L,$$

where the shares, $\overline{v}^K$ and $\overline{v}^L$, are the two-period average shares of the inputs in aggregate value added. As above, we can estimate the sources of aggregate labor productivity, or value added per hour worked, as:

$$(6.8) \qquad \Delta \ln v \equiv \overline{v}^K \Delta \ln k + \overline{v}^L \Delta \ln Q^L + v_T,$$

where the definition of the determinants is the same as for industries, except that there is no intermediate input component.

Aggregate TFP growth in Equation (6.8) is also defined as the sum of "Domar-weighted" industry rates of TFP growth. If we multiply industry productivity growth in Equation (5.3) by the industry share of aggregate value added $\overline{w}_j^V$, divide through by the industry share of value added in output $\overline{v}_j^V$, and sum across all industries, this yields:

$$(6.9) \qquad v_T = \sum_j \frac{\overline{w}_j^V}{\overline{v}_j^V} v_{T,j} \; .$$

The ratio of the two proportions – the so-called Domar weight – captures both the relative importance of the industry in value added for the economy as a whole and the relative importance of value added in the industry's output.[25] The numerator is the proportion of each industry's value added in aggregate value added. The denominator is the proportion of value added in the industry's output. Note that the sum of the Domar weights exceeds unity and that the industry sum of Domar weights is the inverse of the ratio of value added to gross output at the aggregate level. This ingenious weighting scheme, originated by Domar (1961), plays a key role in our framework for aggregation over industries.

An important feature of our methodology is that we are able to identify the contributions of individual industries to aggregate economic growth. This includes both the direct contribution to value added and the flows of goods and services among industries as intermediate inputs in the inter-industry transactions tables. Triplett (1996), for example, has quantified the role of semiconductors as an input into the computer industry. Under plausible assumptions, falling semiconductor prices account for essentially all of the price decline in computers. Building on this observation, Oliner and Sichel (2000) have constructed a model of the U.S. economy with three industries – computers, semiconductors, and all other products.

An alternative aggregation methodology, employed by Jorgenson, Gollop, Fraumeni (1987, Ch. 9), is based on an aggregate production function. Here, the price of a unit of value added must be the same in all industries in order to reduce the production possibility frontier to an aggregate production function. Under this assumption, value added from the aggregate production function, V^*, is defined as a simple sum across industries:

$$(6.10) \qquad V^* = \sum_j V_j \; .$$

Based on V^*, Z, and H, we define a measure of TFP growth at the aggregate production function approach as:

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[25] Our approach to defining aggregate TFP growth is based on the production possibility frontier introduced as "aggregation over industries" in Jorgenson, Ho, and Stiroh (2005). Their aggregate TFP growth is almost equivalent with ($v_T + Q^{KA} + Q^{LA}$) in this paper.

$$(6.11) \quad v_T^* \equiv \Delta \ln V^* - \bar{v}^K \Delta \ln Z - \bar{v}^L \Delta \ln H .$$

Substituting Equations (6.6) and (6.12) to Equation (6.8), aggregate TFP growth v_T is decomposed to v_T^*, the three components of quality change in capital and labor inputs, and the reallocation of value added Q^{VA}:

$$(6.12) \quad v_T = v_T^* + Q^{VA} - \bar{v}^K \left(Q^{KI} + Q^{KA} + Q^{KO}\right) - \bar{v}^L \left(Q^{LI} + Q^{LA} + Q^{LO}\right).$$

where

$$(6.13) \quad Q^{VA} = \frac{V}{V^*} .$$

This decomposition shows that TFP for an aggregate production function: v_T^*, has three allocation biases of value added, capital, and labor, two quality change biases of capital and labor, and two other aggregation biases.

VI. Empirical Results

i. Growth in IT Production

Table 2 represents growth in aggregate value added and its sources. Aggregate value added is defined by real gross domestic product at factor cost, separately for IT manufacturing industries — Computers, Communications Equipment, and Electronic Components — Non-IT manufacturing, and Non-manufacturing. During 1960-1973, the contribution of IT manufacturing is only 0.23 percent in 9.89 percent growth rate of aggregate value added. The contribution expands to 0.31 during 1973-1990. After the bursting of the bubble economy, value added growth declines rapidly in the Japanese economy. The contribution of IT manufacturing is only 0.15 percent during 1990-1995.

Since 1995, however, IT manufacturing has contributed 0.41 percent to aggregate value added. IT manufacturing revives relative to other industries, so that almost one third of the growth in aggregate value added is generated by the growth of IT manufacturing in the late 1990s. Resurgence of three IT manufacturing industries after 1995 is shown in Figures 1 and 2; Figure 1 is value added growth and the industry contribution to aggregate value added during 1995-2000 and Figure 2 is the difference between the growth rate and the industry contribution from the early 1990s to the late 1990s. In the late 1990s, the three IT manufacturing industries have the highest growth of value added in our forty-seven sectors. Communications Equipment, especially, shows the largest improvement — almost 30 percent of value added growth. Also, the growth of the Computer industry improves by more than 20 percent.

(Insert Figure 1 and Figure 2)

Gross and net output growth by industry is given in Tables 7 and 8. The high growth rate of IT manufacturing is very persistent. During the periods 1960-2000, the three IT manufacturing industries have the highest rates of value added growth. However, the value added share of three IT industries is small, even in 2000. Table 5 presents value added shares by industry in 1960, 1973, 1990, 1995, and 2000. The value added share of the three IT manufacturing industries is only 1.83 percent in 2000. The relative importance of IT manufacturing in value added in the U.S. is similar. Based on Jorgenson, Ho, and Stiroh (2005), the share of value added of the three IT manufacturing industries is 1.62 percent in 2000.

In 1960, the largest industry in terms of value added is Agriculture, Forestry, and Fishery. This industry has a 12.96 percent share of value added. The relative importance rapidly declines to 5.50 percent in 1970 and only 1.35 percent in 2000. By contrast service industries, defined as a sum of industries 30-45, gradually expand from 36.50 percent to 50.39 percent of total value added from 1960 to 2000. Clearly, the Japanese industry structure shifts toward service industries in this period. Among manufacturing industries, the largest industry is Iron and Steel in 1960. Although this industry occupied 3.32 percent in 1960, the share decreases to 1.08 percent in 2000. Only six manufacturing industries — three IT manufacturing industries, Other Electric Machinery, Printing and Publishing, and Other Manufacturing— expand in relative importance in value added for the economy as a whole.

Within IT manufacturing, the Computers industry expands in importance until the end of the 1980s. From the beginning of the 1990s, when the Japanese personal computer market became internationally competitive, the value added contribution of Computers within IT manufacturing decreases, as shown in Table 2. On the other hand, the Electronic Components industry has expanded in importance. In the U.S. the Electronic Components industry also has the largest share of three IT manufacturing industries — 49.91 percent in 2000. Relative to the U.S., however, Electronic Components industry is more significant in Japanese IT manufacturing. In 2000, 72.94 percent of value added in IT manufacturing is generated by Electronic Components industry. In comparisons between the U.S. and Japan, the difference in the composition of IT manufacturing should be noted.

ii. IT and Non-IT Capital

The contribution to the economic growth of IT capital, about 0.2 percent annually from the 1960s to the middle of the 1990s, is shown in Table 2. After 1995 the IT capital contribution increased by a factor of two. Figure 3 represents the contribution of IT capital to total capital input for the economy as a whole. In the 1980s, IT capital contributes 31.89 percent of the growth of total capital inputs in the U.S., as measured by Jorgenson, Ho, and Stiroh (2005), but only 13.52 percent in Japan. Since 1995, the

Japanese economy has rapidly shifted its capital allocation from Non-IT capital to IT capital. In 2000, the contribution of the IT capital rose to 42.47 percent, approaching the 46.04 percent in the U.S.

(Insert Figure 3)

In the 1990s, Japanese economic growth depends mainly on the growth of capital input; by contrast labor input actually decreases. The contribution of Non-IT capital is 1.68 percent annually in the early 1990s and decreases to less than half that in the late 1990s. Accelerated growth of IT capital input, especially Computers, partly compensates for the decrease. The contribution of Computers, which includes software embedded in the computer hardware, is 0.22 percent. The contribution of computer software – Custom, Pre-packaged, and Own-Account Software – also expands to 0.10 percent in this period.

In the U.S. the impacts of IT capital on U.S. economic growth in the late 1990s led to a resurgence of U.S. economic growth. In examining the impact of IT capital in Japan, the differences between the U.S. and Japan must be recognized. Table 10 gives growth rates of capital input by industry. From the early 1990s to the late 1990s, the growth of the capital input falls in most of the Japanese industries, while capital input expands in most U.S. industries. In other words, the impact of IT capital in the U.S. is enhanced by the economy-wide expansion of the U.S. economy in the late 1990s. The surge of investment in IT capital in Japan took place during a lengthy recession. The financial sector was immobilized by holdings of worthless assets, the non-financial corporate sector was restructuring its business in order to deal with the decline in demand and intensified international competition, and the household sector confronted the imbalance between the depreciated value and the financial liability in residences purchased during the bubble economy in the late 1980s.

The annual growth rate of IT capital input in Japan is a surprisingly 11.26 percent in the late 1990s, as shown in Table 2. The growth rate in Japan is much lower than the 19.28 percent growth in the U.S., measured by Jorgenson, Ho, and Stiroh (2005). However, the growth of IT capital in Japan had a very significant role in growth, since Non-IT capital in Japan expands by only 1.87 percent in this period, relative to the 3.09 percent in the U.S. We conclude that, despite the long economic recession in Japan, the rapid technological progress in the IT-producing industries diffuses through the production system through capital accumulation in the IT-using industries.

Growth rates in IT capital and Non-IT capital by industry are presented in Tables 11 and 12, respectively. Although growth in the capital input decreases in most industries from the early 1990s to the late 1990s, the growth of IT capital input increases. In almost all industries, except for Metal Products and Electricity, the growth of IT capital is greater than the growth of Non-IT capital. The Household sector has the highest growth of IT capital input, over 25 percent during 1995-2000, due to the expansion in personal computers and cellular phones as consumer durables. Eight service industries, including Finance and Insurance, Railroad Transportation, and Medical Care, expand the input of IT capital by more than 10 percent annually.

Tables 13 and 14 represent industry contributions to IT and Non-IT capital input for the economy as a whole. The sum of contributions to IT capital for the manufacturing industries is 1.03 percent in the late 1990s, only 9.18 percent of IT capital expansion. Service industries are most important for both IT and Non-IT capital. The Finance and Insurance industry is one of the largest contributors to IT capital expansion, but this industry does not contribute to Non-IT capital at all. On the other hand, the Household sector contributes only 0.17 percent to the growth of IT capital during 1960-1973, although this sector has the highest contribution of Non-IT capital in this period. Capital allocation among assets has gradually shifted toward the Household sector. In the late 1990s, this sector's contribution to IT capital is 1.88 percent.

Although manufacturing industries are not the main contributors to IT capital, some manufacturing industries are highly IT-capital-intensive. Table 15 gives the shares of IT capital in total capital cost by industry. The most IT-capital-intensive industry is Computers with a share of IT-capital cost of 46.86 percent in 2000. Figure 4 shows the capital cost structure in four highest IT-capital-intensive industries in 2000. Computer software has the largest share in IT capital in the Computers industry.[26] Communications Equipment has the largest share of capital cost in the Communications industry, where the cost of IT capital is 40.22 percent of the total. Finance and Insurance has a 34.45 percent share of IT capital cost, of which 16.94 percent is the capital cost of Computers. The rate of technological progress is not uniform among different types of IT capital, so that different rates of progress have been incorporated into the production system, depending on the capital structure in each industry.

(Insert Figure 4)

Table 2 represents the contributions of capital and labor inputs to the growth of value added at the economy-wide level. During 1960-2000, the contribution of capital input is 3.05 percent annually, so that the growth of capital inputs explains 56.81 percent of the Japanese economic growth. The role of capital in Japan is very similar to that in the U.S., where capital input contributes 56.49 percent during 1977-2000. This estimate by Jorgenson, Ho, and Stiroh (2005) is based on similar accounting concepts. As

[26] Within computer software, own-account software has a share of 30.4 percent of software cost in the Computers industry. In 2000 own-account software has a larger share, especially in Machinery (64.5 percent) and Research (62.9 percent), where industry-specific software is required.

pointed out by Nomura (2004a), the difference in sources of long-term economic growth in the U.S. and Japan is in the contribution of non-capital inputs. The growth of labor input contributes 38.63 percent of the U.S. economic growth during 1977-2000, by comparison with 18.08 percent in Japan. Relative to Japan, the U.S. economic growth is more labor-intensive. Japanese economic growth depends more heavily on productivity growth, reflecting the opportunities for "catching up" with the U.S. and other industrialized economies during the period 1960-2000.

iii. Productivity and IT

The aggregate TFP contribution to the Japanese economy as a whole is shown in Table 2. Until the beginning of the 1970s, rapid economic growth approaching 10 percent per year was supported by the TFP growth of 3.05 percent. Of this TFP growth 2.02 percent is contributed by Non-IT manufacturing, 0.86 percent by Non-manufacturing, and only 0.17 percent by IT manufacturing. TFP growth by industry is shown in Table 19. Even in the period 1960-1973, the TFP growth in the three IT manufacturing industries was highest; however, the small Domar weights of IT manufacturing industries resulted in a relatively small contribution.[27]

During 1973-1990, aggregate TFP contributes only 0.88 percent annually to Japanese economic growth. The serious decline of the TFP contribution can be found in Non-IT manufacturing and Non-manufacturing industries. The TFP contribution of the IT manufacturing industries increases to 0.20 percent. The increase of the contribution in IT manufacturing is due to the high TFP growth rate in Computers of 8.54 percent, shown in Table 19, accompanied by a rapid expansion in the Domar weight.

In the early 1990s aggregate TFP turns negative. The overall contribution is –0.48 percent, –0.30 percent in Non-IT manufacturing and –0.27 percent in Non-manufacturing. Even in IT manufacturing, the contribution is only 0.09 percent. In this period, the TFP growth in Computers is only 1.03 percent annually; by contrast the U.S. computer industry has TFP growth of 11.87 percent (Jorgenson, Ho, and Stiroh, 2005). The weakness in price competition in the closed Japanese market is clearly evident in this period. Value added growth in Computers declines remarkably from 32.65 percent growth during 1973-1990 to 3.34 percent in the early 1990s, as represented in Table 8. In this period, Communications Equipment has a negative value added growth rate.

Relative to other industries, IT manufacturing revived after 1995, so that the annual growth rates of value added in the three IT manufacturing industries exceeds 20 percent. Figure 5 gives TFP growth and the industry contribution to aggregate TFP in the late 1990s. The growth rate of TFP is 6.38 percent

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[27] Domar weights by industry are represented in Table 6. By definition, the industry-sum of value added weights in Table 5 is 100 and the industry-sum of Domar weights is over 100; the industry-sum is 242.7 in 1960 and gradually

for Computers, 7.07 percent for Communications Equipment, and 7.96 percent for Electronic Components, respectively. The contribution of TFP growth in IT manufacturing to the economic growth at the economy-wide level is 0.39 percent, which is four times higher than the contribution in the early 1990s.

(Insert Figure 5 and Figure 6)

Figure 6 shows the differences between the TFP growth rates and industry contributions in the early 1990s and the late 1990s. By comparison, Figure 2 shows the differences in value added by industry. The industry TFP growth improved more broadly than industry value added growth. Although the TFP growth rates are small or negative in Non-IT manufacturing industries in the late 1990s, the differences between the two periods show widespread improvements. At the economy-wide level, the TFP contribution of Non-IT manufacturing recovers from –0.30 percent to 0.29 percent, as shown in Table 2. The revival in the Other Electric Machinery industry is especially notable during this period. The TFP growth is 4.11 percent in the late 1990s, which is higher than the 3.77 percent growth during 1960-1973. The Domar weight in this industry is greater than the sum of the Domar weights in three IT manufacturing industries. In Japanese economy TFP growth in Non-IT manufacturing has recovered since 1995.

The recovery of TFP growth in the late 1990s is not apparent in Non-manufacturing industries,. However, within the service industries, TFP growth revives in the two industries; the Communications industry has a TFP growth rate of 3.58 percent and Finance and Insurance industry a rate of 2.27 percent. Both industries are highly IT-capital-intensive, as shown in Figure 4. No obvious increases in TFP growth in the IT-using industries are found in the U.S. productivity statistics presented by Jorgenson, Ho, and Stiroh (2005). On the other hand, the widespread TFP gains in the U.S. in the late 1990s are still not apparent in Japan. Figure 7 represents TFP indexes in twelve selected industries. Two representative industries within Non-manufacturing with no improvement are the Wholesale and Retail industry and the Construction industry. Both strongly impact economy-wide growth due to large Domar weights. The TFP indexes in both industries decrease from the beginning of the 1990s.

(Insert Figure 7)

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decreases to 185.7 in 2000. The increase in the rate of value added leads to a decrease in the industry-sum of Domar weights.

Table 3 represents the growth rates of the aggregate production function TFP. This includes aggregation bias in value added, capital input, and labor input. In every sub-period, this measure is greater than the growth rate of aggregate TFP. In the 1990s, the over-estimate exceeds 1.0 percent per year. Table 4 shows the growth rate of average labor productivity (ALP) and its decomposition. In the late 1990s, despite the resurgence of aggregate TFP growth, aggregate ALP growth declines slightly from the early 1990s, due to decreases in capital deepening and labor quality. ALP growth is heavily influenced by particular labor-intensive industries.

Labor productivity by industry is shown in Table 20. In a number of industries, labor productivity growth has improved since 1995. However, some labor-intensive industries have decreased their labor productivity growth. The Construction industry and Wholesale and Retail industry have negative growth in labor productivity in the late 1990s. Ironically, the increase of unemployment due to the long recession generated additional labor supplies for both industries. Figure 7 represents the labor productivity indexes for selected industries, measured in the right axis. In IT-capital-intensive industries – three IT manufacturing industries, Communications, and Finance and Insurance industry – the growth of labor productivity is higher than TFP growth in the late 1990s.

VII. Conclusion

In the 1990s the resurgence of the U.S. economy stimulated optimism, while the long recession of the Japanese economy engendered pessimism. The optimistic view for the U.S. economy has been supported by the widespread impact of IT. Contrary to the Solow Paradox, the observed facts about IT impacts can be found everywhere in the productivity statistics since the late 1990s. The enhanced role of investment in IT is a conspicuous feature of the U.S. economy and a growth revival is under way in many important IT-using industries. Our major goal in this paper is to characterize the role of IT in the Japanese economy, especially in the "lost decade" of the 1990s.

Our main conclusion is a growth revival can be spotted in many Japanese industries. This can be clearly detected in the growth of value added and productivity in IT manufacturing industries and IT-using industries like Communications and Finance and Insurance since 1995. Even during economic recession periods in Japan, IT capital has been incorporated into the production structure. The IT-intensive industries have generated a modest recovery in the growth of TFP and labor productivity in the Japanese economy.

However, widespread diffusion of IT is absent in the Japanese economy by 2000. Due to the differences in economic conditions, the Japanese economy has responded to the progress of IT in a different way from the U.S. economy. The dwindling of demand and the restructuring of the economy have inhibited the spread of IT in Japan. For many of the Non-IT manufacturing and Non-manufacturing industries, the shift from Non-IT capital to IT capital has been postponed into the future and widespread productivity gains are still to come.

Relative to the U.S., the growth of Japanese economy during the period 1960-1973 depended more heavily on growth in TFP, as Japanese industries approached the levels of technology in their U.S. counterparts. This process slowed dramatically after 1973 and then reversed course in the early 1990s. The growth rate of labor quality is decreasing in Japan, as in other countries. Unlike other countries, the labor force in Japan has already entered a phase of decline. Future growth will depend on a revival of capital deepening and investment in information technology will continue to have an essential role.

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Table 1: Asset Classification and Depreciation Rates

1	Trees	0.200	52	Steel ships	0.108
2	Livestock	0.309	53	Other ships	0.166
3	Textile products	0.347	54	Railway vehicles	0.068
4	Wooded products	0.236	55	Aircraft	0.135
5	Wooden furniture and fixtures	0.171	56	Bicycles	0.498
6	Metallic furniture and fixtures	0.098	57	Transport equipment for industrial use	0.217
7	Nuclear fuel rods	0.413	58	Other transport equipment	0.332
8	Metallic products	0.086	59	Camera	0.210
9	Boilers and turbines	0.102	60	Other photographic and optical instruments	0.218
10	Engines	0.112	61	Watches and clocks	0.118
11	Conveyors	0.098	62	Physics and chemistry instruments	0.236
12	Refrigerators and air conditioning apparatus	0.116	63	Analytical and measuring instruments and testing machines	0.236
13	Pumps and compressors	0.118	64	Medical instruments	0.199
14	Sewing machines	0.112	65	Miscellaneous manufacturing products	0.274
15	Other general industrial machinery and equipment	0.142	66	Residential construction (wooden)	0.048
16	Mining, civil engineering and construction machinery	0.171	67	Residential construction (non-wooden)	0.031
17	Chemical machinery	0.143	68	Non-residential construction (wooden)	0.057
18	Industrial robots	0.150	69	Non-residential construction (non-wooden)	0.039
19	Metal machine tools	0.127	70	Road construction	0.020
20	Metal processing machinery	0.111	71	Street construction	0.020
21	Agricultural machinery	0.098	72	Bridge construction	0.020
22	Textile machinery	0.117	73	Toll road construction	0.020
23	Food processing machinery	0.113	74	River improvement	0.019
24	Sawmill, wood working, veneer and plywood machinery	0.137	75	Erosion control	0.019
25	Pulp equipment and paper machinery	0.104	76	Seashore improvement	0.018
26	Printing, bookbinding and paper processing machinery	0.127	77	Park construction	0.048
27	Casting equipment	0.107	78	Sewer construction	0.027
28	Plastic processing machinery	0.122	79	Sewage disposal facilities	0.027
29	Other special industrial machinery, nec	0.130	80	Waste disposal facilities	0.061
30	Other general machines and parts	0.208	81	Harbor construction	0.018
31	Office machines	0.347	82	Fishing port construction	0.018
32	Vending, amusement and other service machinery	0.210	83	Airport construction	0.054
33	Electric audio equipment	0.236	84	Agricultural construction	0.028
34	Radio and television sets	0.236	85	Forest road construction	0.034
35	Video recording and playback equipment	0.236	86	Forestry protection	0.019
36	Household electric appliance	0.196	87	Railway construction	0.030
37	Electronic computer and peripheral equipment	0.347	88	Electric power facilities	0.025
38	Wired communication equipment	0.206	89	Telecommunication facilities	0.035
39	Radio communication equipment	0.275	90	Other civil engineering and construction	0.025
40	Other communication equipment	0.118	91	Plant engineering	0.025
41	Applied electronic equipment	0.196	92	Mineral exploration	0.550
42	Electric measuring instruments	0.196	93	Custom software	0.330
43	Generators	0.079	94	Pre-packaged software	0.330
44	Electric motors	0.079	95	Own-account software	0.330
45	Relay switches and switchboards	0.079	96	Finished-goods inventory	0.000
46	Other industrial heavy electrical equipment	0.109	97	Work-in-process inventory	0.000
47	Electric lighting fixtures and apparatus	0.079	98	Material inventory	0.000
48	Passenger motor vehicles	0.163	99	Land for agricultural use	0.000
49	Trucks, buses and other vehicles	0.228	100	Land for industrial use	0.000
50	Two-wheel motor vehicles	0.218	101	Land for commercial use	0.000
51	Motor vehicle parts	0.208	102	Land for residential use	0.000

Note: Assets 48-49 and 66-67; Estimates of Nomura (2004, Ch-2) based price data at the markets for rental and second-hand goods.
Other Assets; Estimates based the Japanese tax-lives years estimated by Nomura and the BEA's declining balance rates.

Table 2: Growth in Aggregate Value Added and Its Sources

	1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
Contributions					
Value-Added	9.89	4.29	1.27	1.34	5.37
IT Manufacturing	0.23	0.31	0.15	0.41	0.28
Computers	0.04	0.11	0.01	0.08	0.07
Communications Equipment	0.04	0.02	0.00	0.07	0.03
Electronic Components	0.15	0.18	0.14	0.26	0.18
Non-IT Manufacturing	4.16	1.08	-0.24	0.19	1.80
Non-Manufacturing	5.50	2.90	1.36	0.74	3.28
Capital Input	5.16	2.32	1.90	1.17	3.05
IT Assets	0.21	0.24	0.22	0.41	0.25
Computers	0.07	0.10	0.10	0.22	0.10
Communications Equipment	0.13	0.05	0.05	0.09	0.08
Custom Software	0.01	0.05	0.04	0.08	0.04
Prepackaged Software	0.00	0.01	0.01	0.01	0.00
Own-Account Software	0.02	0.03	0.02	0.01	0.02
Non-IT Assets	4.94	2.08	1.68	0.76	2.80
Labor Input	1.69	1.09	-0.15	-0.18	0.97
Aggregate TFP	3.05	0.88	-0.48	0.35	1.35
IT Manufacturing	0.17	0.20	0.09	0.39	0.20
Computers	0.02	0.07	0.01	0.10	0.05
Communications Equipment	0.03	0.02	-0.01	0.07	0.02
Electronic Components	0.12	0.12	0.09	0.23	0.13
Non-IT Manufacturing	2.02	0.53	-0.30	0.29	0.88
Non-Manufacturing	0.86	0.14	-0.27	-0.33	0.26
Growth					
Value-Added	9.89	4.29	1.27	1.34	5.37
IT Manufacturing	28.98	27.24	9.08	23.00	25.00
Non-IT Manufacturing	14.47	4.74	-1.18	1.03	6.70
Non-Manufacturing	7.81	3.86	1.77	0.93	4.52
Capital Input	10.18	5.15	4.14	2.65	6.35
IT Assets	26.02	13.89	7.23	11.26	16.67
Computers	48.09	20.51	9.29	15.82	27.48
Communications Equipment	21.36	8.37	9.70	12.02	13.21
Custom Software	26.30	18.50	4.90	8.69	18.11
Prepackaged Software	26.50	17.84	7.17	8.36	18.13
Own-Account Software	32.50	10.48	3.59	2.13	15.73
Non-IT Assets	9.92	4.80	3.91	1.87	5.99
Labor Input	3.42	1.99	-0.28	-0.33	1.88

Note: All figures are average annual growth rates.Value added is aggregated from industry GDPs evaluated at the factor cost. The contribution of value added is the growth rate multiplied by the average value shares.

Table 3: Growth in Aggregate Production Fuction TFP

	1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
Aggregate Production Fuction TFP	3.72	1.89	0.51	1.27	2.24
(+) Allocation Change of Value Added	2.63	0.55	0.05	-0.40	1.04
(-) Contribution of Capital Quality	2.76	0.83	0.66	0.31	1.37
Quality Change	2.01	0.51	0.08	0.23	0.91
Allocation Change	0.48	0.19	0.35	-0.04	0.27
Other Change	0.28	0.13	0.23	0.13	0.19
(-) Contribution of Labor Quality	0.54	0.74	0.39	0.20	0.56
Quality Change	0.27	0.54	0.27	0.16	0.37
Allocation Change	-0.19	-0.28	-0.16	-0.92	-0.32
Other Change	0.46	0.48	0.29	0.96	0.51
Aggregate TFP	3.05	0.88	-0.48	0.35	1.35

Note: All figures are average annual growath rates.

Table 4: Decomposition of Aggregate Labor Productivity

	1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
Aggregate Labor Productivity	7.58	3.63	2.27	2.02	4.55
Capital Deepening	4.00	2.02	2.36	1.48	2.64
IT Assets	0.20	0.22	0.25	0.44	0.25
Computers	0.07	0.10	0.11	0.23	0.11
Communications Equipment	0.11	0.04	0.06	0.10	0.07
Custom Software	0.01	0.05	0.05	0.09	0.04
Prepackaged Software	0.00	0.01	0.01	0.01	0.00
Own-Account Software	0.02	0.03	0.02	0.01	0.02
Non-IT Assets	3.79	1.79	2.11	1.04	2.39
Labor Quality	0.54	0.74	0.39	0.20	0.56
Aggregate TFP	3.05	0.88	-0.48	0.35	1.35
IT	0.17	0.20	0.09	0.39	0.20
Non-IT	2.88	0.67	-0.57	-0.04	1.14

Note: All figures are average annual growath rates.

Table 5: Industry Value Added Weights by Subperiod

		1960	1973	1990	1995	2000
1	Agriculture, Forestry, Fishery	12.96	5.50	2.25	1.77	1.35
2	Coal Mining	0.88	0.08	0.02	0.01	0.01
3	Other Mining	0.61	0.60	0.21	0.17	0.14
4	Construction	5.30	7.90	8.90	9.05	7.75
5	Foods	3.14	2.12	1.92	1.99	2.03
6	Textile	2.70	1.46	0.48	0.36	0.24
7	Apparel	0.42	0.58	0.53	0.37	0.24
8	Woods and Related Products	0.73	0.76	0.30	0.24	0.19
9	Furniture and Fixture	0.33	0.59	0.34	0.24	0.20
10	Paper and Pulp	0.96	0.82	0.68	0.64	0.58
11	Printing and Publishing	0.97	0.98	1.16	1.10	1.09
12	Chemical Products	2.71	2.29	2.15	1.94	1.78
13	Petroleum Refining	0.93	0.76	0.28	0.40	0.50
14	Coal Products	0.11	0.14	0.11	0.07	0.08
15	Rubber Products	0.40	0.31	0.29	0.23	0.21
16	Leather Products	0.08	0.13	0.09	0.06	0.05
17	Stone, Clay, Glass	1.22	1.43	0.87	0.73	0.62
18	Iron and Steel	3.32	2.83	1.53	1.23	1.08
19	Non-ferrous Metal	0.69	0.96	0.46	0.35	0.31
20	Metal Products	1.33	2.02	1.46	1.22	1.01
21	Machinery	2.81	2.84	3.26	2.56	2.56
22	Computers	0.01	0.16	0.63	0.35	0.22
23	Communications Equipment	0.18	0.21	0.24	0.22	0.27
24	Electronic Components	0.55	0.54	0.91	1.12	1.34
25	Other Electrical Machinery	1.95	2.30	2.36	1.87	2.06
26	Motor Vehicles	1.80	2.83	2.09	1.88	1.76
27	Other Transportation Equipment	0.90	0.67	0.32	0.26	0.23
28	Precision Instruments	0.49	0.55	0.45	0.32	0.35
29	Other Manufacturing	0.64	1.17	1.16	0.99	0.92
30	Railroad Transportation	1.95	0.91	0.84	0.69	0.57
31	Road Transportation	2.07	2.39	2.66	2.63	2.21
32	Water Transportation	1.29	0.64	0.46	0.43	0.33
33	Air Transportation	0.06	0.16	0.26	0.24	0.22
34	Storage Facility Service	0.28	0.31	0.31	0.29	0.26
35	Communications	1.58	1.43	1.74	1.94	2.39
36	Electricity	1.56	0.90	1.65	2.04	1.89
37	Gas Supply	0.41	0.18	0.22	0.26	0.28
38	Water Supply	0.20	0.27	0.36	0.43	0.50
39	Wholesale and Retail	10.36	12.20	11.40	10.32	8.90
40	Finance and Insurance	3.31	4.59	5.40	4.47	4.87
41	Real Estate	3.41	3.51	3.71	4.70	5.40
42	Education	2.46	2.48	3.31	3.49	3.63
43	Research	0.10	0.15	0.23	0.26	0.29
44	Medical Care	1.87	2.32	3.08	3.87	4.79
45	Other Service	5.61	8.09	11.25	12.88	13.87
46	Public Administration	4.95	5.14	5.90	6.48	6.78
47	Household	9.47	10.86	11.79	12.84	13.70
	Sum	100.00	100.00	100.00	100.00	100.00

Note: All figures are shares.Value added is defined at factor cost.

Table 6: Industry Domer Weights by Subperiod

		1960	1973	1990	1995	2000
1	Agriculture, Forestry, Fishery	22.58	8.79	4.15	3.27	2.62
2	Coal Mining	1.37	0.14	0.03	0.02	0.01
3	Other Mining	0.97	1.01	0.43	0.36	0.30
4	Construction	19.44	22.75	19.56	18.82	16.15
5	Foods	13.25	8.16	6.43	6.16	5.93
6	Textile	12.40	5.50	1.57	0.98	0.65
7	Apparel	2.32	1.94	1.45	1.04	0.65
8	Woods and Related Products	3.72	3.00	1.01	0.84	0.60
9	Furniture and Fixture	1.01	1.68	0.86	0.69	0.49
10	Paper and Pulp	4.11	3.17	2.10	1.82	1.60
11	Printing and Publishing	2.38	2.27	2.53	2.40	2.31
12	Chemical Products	10.04	6.88	5.71	5.04	4.81
13	Petroleum Refining	2.35	2.40	1.57	1.32	1.73
14	Coal Products	0.57	0.45	0.34	0.21	0.23
15	Rubber Products	1.43	0.85	0.75	0.61	0.56
16	Leather Products	0.34	0.44	0.26	0.18	0.12
17	Stone, Clay, Glass	3.14	3.69	2.15	1.82	1.50
18	Iron and Steel	18.86	13.30	5.96	4.39	4.00
19	Non-ferrous Metal	3.13	3.22	1.62	1.24	1.08
20	Metal Products	3.71	5.16	3.52	2.99	2.41
21	Machinery	8.52	8.92	8.68	7.06	6.78
22	Computers	0.01	0.44	1.81	1.53	1.39
23	Communications Equipment	0.52	0.66	0.79	0.79	1.01
24	Electronic Components	1.46	1.45	2.43	2.70	3.31
25	Other Electrical Machinery	7.39	6.79	6.15	5.14	5.17
26	Motor Vehicles	6.72	8.72	8.14	7.02	6.84
27	Other Transportation Equipment	2.62	1.79	0.94	0.76	0.68
28	Precision Instruments	1.34	1.40	1.06	0.78	0.77
29	Other Manufacturing	2.32	3.31	3.36	2.85	2.59
30	Railroad Transportation	2.92	1.47	1.66	1.51	1.45
31	Road Transportation	3.37	3.36	4.01	4.02	3.70
32	Water Transportation	2.24	1.58	1.16	1.01	0.90
33	Air Transportation	0.13	0.38	0.62	0.60	0.67
34	Storage Facility Service	0.37	0.54	0.55	0.47	0.50
35	Communications	2.21	1.88	2.40	2.87	3.83
36	Electricity	2.98	1.94	2.83	3.02	2.92
37	Gas Supply	0.75	0.36	0.38	0.41	0.47
38	Water Supply	0.24	0.37	0.56	0.60	0.68
39	Wholesale and Retail	20.59	19.77	18.74	17.86	15.38
40	Finance and Insurance	5.44	6.29	8.43	7.19	7.91
41	Real Estate	3.72	3.87	4.16	5.29	6.17
42	Education	3.34	2.96	3.90	4.18	4.33
43	Research	0.14	0.18	0.31	0.33	0.36
44	Medical Care	3.33	4.00	5.78	6.79	8.11
45	Other Service	16.52	16.48	21.58	24.82	26.83
46	Public Administration	6.39	6.43	7.67	8.55	9.39
47	Household	9.97	11.66	13.18	14.51	15.79
	Sum	242.68	211.78	193.28	186.84	185.68

Note: All figures are shares.Value added is defined at factor cost.

Table 7: Growth of Industry Output by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	2.51	0.66	-0.76	-2.91	0.64
2	Coal Mining	-5.19	-6.78	-6.71	-14.08	-7.17
3	Other Mining	13.47	-0.75	-5.19	0.18	3.43
4	Construction	10.16	3.04	0.19	-1.90	4.38
5	Foods	8.76	2.42	0.23	-0.67	3.82
6	Textile	4.12	0.13	-3.83	-6.06	0.16
7	Apparel	8.97	3.44	-4.62	-8.48	2.74
8	Woods and Related Products	6.49	-0.57	-1.62	-4.76	1.07
9	Furniture and Fixture	13.83	0.51	-3.08	-5.64	3.62
10	Paper and Pulp	10.70	2.07	-1.12	-1.25	4.06
11	Printing and Publishing	7.74	3.31	-0.04	-0.15	3.90
12	Chemical Products	12.75	3.41	0.70	-0.04	5.67
13	Petroleum Refining	14.07	0.42	3.80	0.02	5.23
14	Coal Products	11.56	0.69	-1.86	2.95	4.19
15	Rubber Products	10.10	4.23	-1.97	-0.83	4.73
16	Leather Products	13.71	0.01	-4.98	-7.68	2.88
17	Stone, Clay, Glass	13.83	0.39	-1.05	-2.13	4.26
18	Iron and Steel	11.94	0.16	-1.76	0.27	3.77
19	Non-ferrous Metal	12.48	2.14	0.29	-0.49	4.94
20	Metal Products	15.98	2.18	-0.77	-2.99	5.65
21	Machinery	13.98	5.36	-1.78	0.76	6.69
22	Computers	45.93	23.47	4.67	10.48	26.80
23	Communications Equipment	17.95	9.80	3.78	15.40	12.39
24	Electronic Components	21.30	17.35	9.01	14.32	17.21
25	Other Electrical Machinery	14.48	5.40	-0.24	5.81	7.70
26	Motor Vehicles	17.34	6.29	-0.52	1.02	8.37
27	Other Transportation Equipment	8.31	1.90	-3.48	-0.12	3.06
28	Precision Instruments	15.08	5.17	-3.70	1.43	6.81
29	Other Manufacturing	16.14	4.63	-0.81	-0.43	7.06
30	Railroad Transportation	3.56	1.91	0.94	-0.49	2.02
31	Road Transportation	9.40	4.17	-1.21	-1.07	4.54
32	Water Transportation	8.13	2.97	-1.75	-1.62	3.48
33	Air Transportation	24.51	7.73	4.19	1.71	11.99
34	Storage Facility Service	7.92	5.75	-1.16	1.73	5.09
35	Communications	11.10	5.85	6.44	11.33	8.31
36	Electricity	11.02	3.76	2.95	1.51	5.74
37	Gas Supply	8.22	4.42	5.09	3.37	5.61
38	Water Supply	11.15	3.61	0.99	0.35	5.33
39	Wholesale and Retail	11.71	4.55	1.05	-1.66	5.67
40	Finance and Insurance	10.22	6.27	-1.51	3.78	6.27
41	Real Estate	7.13	3.13	4.51	3.39	4.63
42	Education	5.59	-0.44	0.23	-0.41	1.61
43	Research	10.07	5.63	-0.51	1.93	5.84
44	Medical Care	11.56	6.29	3.28	0.44	6.90
45	Other Service	7.18	3.81	4.13	2.31	4.76
46	Public Administration	7.71	3.83	2.68	2.13	4.73
47	Household	7.45	5.35	4.25	2.87	5.58
	Average	11.53	3.81	0.16	0.50	5.45

Note: All figures are average annual growth rates.

Table 8: Growth of Industry Value Added by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	2.19	0.27	0.19	-3.33	0.43
2	Coal Mining	-4.86	-8.37	-6.85	-15.71	-7.96
3	Other Mining	13.43	-1.39	-9.45	4.45	3.15
4	Construction	5.87	4.43	-0.24	-1.91	3.52
5	Foods	14.60	0.83	-1.84	-1.30	4.70
6	Textile	1.88	4.79	3.00	-5.65	2.32
7	Apparel	10.57	2.57	-8.59	-9.03	2.32
8	Woods and Related Products	2.35	3.24	-4.56	-1.70	1.36
9	Furniture and Fixture	12.51	0.46	-7.37	-3.50	2.90
10	Paper and Pulp	14.91	4.27	0.24	0.05	6.70
11	Printing and Publishing	4.16	2.33	-0.55	-0.01	2.27
12	Chemical Products	19.10	6.14	2.00	-0.24	9.04
13	Petroleum Refining	12.62	14.21	1.77	4.62	10.94
14	Coal Products	13.61	-0.84	-1.39	4.53	4.46
15	Rubber Products	14.24	4.82	-3.37	-1.08	6.12
16	Leather Products	15.80	-1.12	-3.96	-6.99	3.29
17	Stone, Clay, Glass	14.47	0.72	-0.95	-1.24	4.73
18	Iron and Steel	15.49	3.18	1.09	0.81	6.62
19	Non-ferrous Metal	14.78	5.69	3.49	1.38	7.83
20	Metal Products	16.97	2.27	-2.32	-2.49	5.88
21	Machinery	13.92	7.17	-3.00	1.51	7.38
22	Computers	52.17	32.65	3.34	24.41	34.30
23	Communications Equipment	19.45	12.27	-0.70	28.78	15.04
24	Electronic Components	31.17	29.39	14.60	21.47	27.13
25	Other Electrical Machinery	18.82	6.54	-1.32	12.29	10.27
26	Motor Vehicles	21.53	7.63	-0.34	0.14	10.21
27	Other Transportation Equipment	6.70	2.89	-5.95	0.46	2.72
28	Precision Instruments	18.14	7.60	-5.17	2.70	8.82
29	Other Manufacturing	19.81	4.49	-1.39	-0.04	8.17
30	Railroad Transportation	1.89	-1.16	0.32	-4.86	-0.45
31	Road Transportation	9.00	3.45	-3.09	-2.70	3.67
32	Water Transportation	4.93	4.82	-0.73	-4.88	2.95
33	Air Transportation	30.58	8.42	6.15	-2.82	13.93
34	Storage Facility Service	2.90	7.50	1.17	-2.22	4.00
35	Communications	12.44	6.10	5.70	11.54	8.79
36	Electricity	11.67	4.58	4.33	2.43	6.59
37	Gas Supply	8.96	6.49	6.55	3.68	6.95
38	Water Supply	9.17	1.83	2.51	0.12	4.09
39	Wholesale and Retail	14.79	5.32	0.29	-1.49	6.92
40	Finance and Insurance	12.27	6.13	-1.98	3.92	6.83
41	Real Estate	6.81	2.91	4.30	3.02	4.37
42	Education	5.38	-1.31	-0.58	-0.66	1.04
43	Research	10.71	5.08	-0.81	2.35	5.83
44	Medical Care	9.59	5.58	2.82	-1.61	5.64
45	Other Service	3.02	2.52	3.58	1.88	2.74
46	Public Administration	7.26	3.43	1.99	0.88	4.18
47	Household	7.12	5.17	4.13	2.49	5.34
	Average	12.44	5.02	-0.06	1.37	6.34

Note: All figures are average annual growth rates.

Table 9: Growth of Industry Intermediate Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	2.96	1.26	-1.90	-2.44	0.95
2	Coal Mining	-5.48	-4.72	-6.52	-13.31	-6.27
3	Other Mining	13.39	-0.08	-1.33	-3.61	3.70
4	Construction	12.09	2.31	0.56	-1.88	4.74
5	Foods	6.74	3.06	1.18	-0.37	3.59
6	Textile	4.97	-1.62	-7.44	-6.30	-0.79
7	Apparel	8.33	3.85	-2.40	-8.16	3.02
8	Woods and Related Products	7.87	-1.71	-0.41	-6.08	1.02
9	Furniture and Fixture	14.48	0.58	-0.49	-6.90	4.03
10	Paper and Pulp	9.34	1.22	-1.82	-1.96	3.08
11	Printing and Publishing	10.60	4.03	0.47	-0.29	5.18
12	Chemical Products	9.92	2.24	-0.12	0.07	4.17
13	Petroleum Refining	14.95	-1.18	4.16	-1.90	4.64
14	Coal Products	10.99	1.08	-2.18	2.47	4.07
15	Rubber Products	8.36	3.86	-1.08	-0.69	4.14
16	Leather Products	12.96	0.49	-5.56	-8.01	2.72
17	Stone, Clay, Glass	13.34	0.16	-1.13	-2.74	3.92
18	Iron and Steel	11.19	-0.62	-2.80	0.07	3.03
19	Non-ferrous Metal	11.82	1.09	-1.10	-1.20	4.02
20	Metal Products	15.36	2.10	0.33	-3.36	5.50
21	Machinery	13.98	4.47	-1.06	0.31	6.35
22	Computers	42.27	17.75	5.54	6.99	22.85
23	Communications Equipment	17.10	8.75	5.63	10.57	11.30
24	Electronic Components	14.95	10.82	5.34	9.03	11.25
25	Other Electrical Machinery	12.48	4.75	0.40	2.06	6.38
26	Motor Vehicles	15.45	5.73	-0.59	1.34	7.55
27	Other Transportation Equipment	9.29	1.33	-2.21	-0.43	3.25
28	Precision Instruments	13.15	3.56	-2.62	0.44	5.51
29	Other Manufacturing	14.52	4.71	-0.52	-0.64	6.57
30	Railroad Transportation	6.77	5.99	1.60	2.84	5.30
31	Road Transportation	10.47	5.61	2.66	1.52	6.31
32	Water Transportation	11.24	2.07	-2.37	0.44	4.29
33	Air Transportation	19.86	7.22	2.79	4.21	10.40
34	Storage Facility Service	16.27	3.41	-4.49	6.48	6.99
35	Communications	6.80	5.20	8.17	10.66	6.78
36	Electricity	9.80	2.50	0.82	-0.33	4.31
37	Gas Supply	7.35	2.25	2.76	2.77	4.04
38	Water Supply	18.16	6.83	-1.84	1.10	8.71
39	Wholesale and Retail	7.85	3.39	2.17	-1.87	4.03
40	Finance and Insurance	6.80	6.48	-0.71	3.47	5.31
41	Real Estate	10.12	5.21	6.22	6.26	7.06
42	Education	4.48	4.24	4.60	0.85	3.94
43	Research	8.37	7.40	1.03	0.05	6.00
44	Medical Care	14.12	7.10	3.83	3.30	8.50
45	Other Service	9.58	5.20	4.73	2.80	6.27
46	Public Administration	9.61	5.27	4.88	5.79	6.70
47	Household	12.60	7.13	5.13	5.62	8.47
	Average	11.44	3.65	0.47	0.40	5.38

Note: All figures are average annual growth rates.

Table 10: Growth of Industry Capital Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	2.51	1.45	-0.64	-1.06	1.22
2	Coal Mining	3.44	-0.33	-7.01	-6.47	-0.71
3	Other Mining	9.37	1.46	-0.21	-2.14	3.37
4	Construction	17.03	4.09	9.24	1.54	8.62
5	Foods	10.03	4.11	2.40	1.60	5.51
6	Textile	6.86	-0.10	1.38	-1.76	2.14
7	Apparel	15.33	5.31	3.87	-2.11	7.46
8	Woods and Related Products	9.23	0.65	-0.54	-2.99	2.84
9	Furniture and Fixture	12.63	3.08	2.83	-1.15	5.62
10	Paper and Pulp	9.79	3.03	1.96	0.54	4.78
11	Printing and Publishing	14.36	4.19	4.61	3.05	7.41
12	Chemical Products	10.69	2.98	2.34	1.11	5.17
13	Petroleum Refining	11.83	1.38	2.68	1.02	4.89
14	Coal Products	13.32	0.59	-1.33	-0.69	4.33
15	Rubber Products	9.63	3.51	2.55	0.00	4.94
16	Leather Products	9.45	1.52	3.19	-0.32	4.08
17	Stone, Clay, Glass	11.54	3.48	2.66	1.14	5.71
18	Iron and Steel	12.39	2.83	1.00	-0.42	5.30
19	Non-ferrous Metal	10.06	2.42	2.27	0.49	4.64
20	Metal Products	13.87	7.75	3.13	0.81	8.29
21	Machinery	13.20	5.13	2.75	0.94	6.93
22	Computers	37.27	10.99	5.17	0.78	17.53
23	Communications Equipment	12.07	6.31	3.78	4.35	7.62
24	Electronic Components	13.31	11.83	6.91	5.78	10.94
25	Other Electrical Machinery	10.62	6.24	3.19	1.89	6.74
26	Motor Vehicles	16.56	6.23	2.82	1.13	8.52
27	Other Transportation Equipment	12.09	2.92	2.46	0.57	5.55
28	Precision Instruments	15.01	7.61	2.81	-0.15	8.45
29	Other Manufacturing	16.20	4.46	3.64	2.81	7.97
30	Railroad Transportation	5.20	2.39	1.67	3.33	3.33
31	Road Transportation	12.53	7.56	-0.38	-0.76	7.15
32	Water Transportation	0.43	0.70	0.32	-0.28	0.44
33	Air Transportation	17.95	5.69	-0.69	-1.13	8.02
34	Storage Facility Service	11.84	5.23	6.56	2.51	7.21
35	Communications	14.42	4.42	4.56	5.83	7.86
36	Electricity	4.41	5.78	4.98	3.60	4.96
37	Gas Supply	9.74	5.32	3.41	1.72	6.07
38	Water Supply	13.41	4.41	2.95	3.87	7.08
39	Wholesale and Retail	11.06	5.71	3.34	2.97	6.81
40	Finance and Insurance	10.02	4.97	5.26	4.64	6.60
41	Real Estate	11.49	6.34	4.01	1.69	7.14
42	Education	8.87	4.26	2.59	0.93	5.13
43	Research	11.07	6.98	1.96	3.82	7.28
44	Medical Care	15.26	9.67	6.47	5.71	10.59
45	Other Service	18.53	6.93	3.03	3.86	9.83
46	Public Administration	10.95	6.13	5.65	4.17	7.39
47	Household	7.12	5.17	4.13	2.49	5.34
	Average	11.79	4.53	2.76	1.26	6.26

Note: All figures are average annual growth rates.

Table 11: Growth of Industry IT Capital Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	28.20	10.37	-2.69	2.29	13.52
2	Coal Mining	21.07	0.11	-2.31	-1.05	6.47
3	Other Mining	23.01	4.57	3.67	1.77	10.10
4	Construction	31.87	13.86	10.12	9.64	18.72
5	Foods	26.84	13.50	3.57	7.92	15.90
6	Textile	26.67	13.12	0.52	-1.23	14.15
7	Apparel	27.70	10.66	4.58	3.49	14.54
8	Woods and Related Products	36.66	14.53	2.06	1.48	18.53
9	Furniture and Fixture	37.63	15.65	-0.87	-0.09	18.76
10	Paper and Pulp	22.57	5.44	2.10	4.48	10.47
11	Printing and Publishing	25.27	15.53	4.82	7.41	16.34
12	Chemical Products	24.16	11.85	4.01	7.64	14.34
13	Petroleum Refining	19.54	13.57	3.41	9.14	13.69
14	Coal Products	26.15	16.59	-1.50	6.45	16.17
15	Rubber Products	24.11	10.45	2.04	5.55	13.23
16	Leather Products	27.37	15.86	3.34	1.24	16.21
17	Stone, Clay, Glass	24.28	10.82	5.42	7.53	14.11
18	Iron and Steel	25.37	7.09	-0.84	2.26	11.44
19	Non-ferrous Metal	23.86	11.83	-0.50	4.67	13.30
20	Metal Products	24.69	15.22	-0.87	0.71	14.47
21	Machinery	28.77	13.67	3.31	2.79	15.93
22	Computers	41.91	14.55	4.56	2.48	20.69
23	Communications Equipment	20.42	8.72	3.22	7.29	11.66
24	Electronic Components	23.55	15.65	5.21	6.12	15.72
25	Other Electrical Machinery	25.62	11.06	2.39	6.92	14.19
26	Motor Vehicles	24.84	10.99	4.11	6.13	14.03
27	Other Transportation Equipment	22.89	3.48	-1.49	2.47	9.04
28	Precision Instruments	28.15	18.14	4.40	4.44	17.97
29	Other Manufacturing	29.64	16.24	5.30	9.03	18.32
30	Railroad Transportation	14.58	16.00	8.47	12.49	14.16
31	Road Transportation	29.30	18.42	5.27	7.48	18.94
32	Water Transportation	10.75	-2.13	2.40	11.08	4.27
33	Air Transportation	29.71	9.46	3.61	3.97	14.63
34	Storage Facility Service	27.52	22.03	1.13	3.28	18.86
35	Communications	17.49	13.35	9.55	10.06	13.81
36	Electricity	15.43	12.78	5.91	3.35	11.60
37	Gas Supply	22.51	10.70	4.62	4.72	13.03
38	Water Supply	34.94	22.10	6.00	10.42	22.80
39	Wholesale and Retail	28.91	15.24	2.80	8.01	17.22
40	Finance and Insurance	28.57	13.87	6.75	15.45	17.95
41	Real Estate	47.11	17.12	2.07	11.92	24.34
42	Education	39.15	15.83	9.60	3.24	21.06
43	Research	36.77	15.06	1.00	5.76	19.20
44	Medical Care	33.24	14.61	18.23	12.21	20.82
45	Other Service	40.09	14.34	6.88	11.63	21.44
46	Public Administration	24.02	18.14	13.60	9.65	18.42
47	Household	18.46	23.04	22.64	25.35	21.79
	Average	27.05	13.04	4.29	6.36	15.67

Note: All figures are average annual growth rates.

Table 12: Growth of Industry Non-IT Capital Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	2.45	1.36	-0.63	-1.10	1.16
2	Coal Mining	3.27	-0.33	-7.10	-6.58	-0.79
3	Other Mining	9.28	1.41	-0.25	-2.19	3.31
4	Construction	16.95	3.94	9.22	1.23	8.49
5	Foods	9.94	3.95	2.35	1.28	5.36
6	Textile	6.81	-0.40	1.50	-1.81	2.00
7	Apparel	15.10	5.10	3.88	-2.80	7.21
8	Woods and Related Products	9.22	0.56	-0.59	-3.14	2.77
9	Furniture and Fixture	12.60	2.94	2.98	-1.22	5.57
10	Paper and Pulp	9.41	2.98	1.96	0.43	4.62
11	Printing and Publishing	14.22	3.50	4.62	1.77	6.91
12	Chemical Products	10.51	2.70	2.24	0.61	4.92
13	Petroleum Refining	11.78	1.16	2.64	0.76	4.75
14	Coal Products	13.30	0.42	-1.32	-0.95	4.22
15	Rubber Products	9.45	3.30	2.57	-0.61	4.72
16	Leather Products	9.42	1.38	3.20	-0.41	3.99
17	Stone, Clay, Glass	11.47	3.39	2.57	0.76	5.58
18	Iron and Steel	12.21	2.71	1.06	-0.51	5.19
19	Non-ferrous Metal	9.90	2.17	2.43	0.25	4.48
20	Metal Products	13.75	7.43	3.41	0.79	8.15
21	Machinery	13.07	4.88	2.70	0.78	6.76
22	Computers	36.70	10.21	5.58	-0.64	16.88
23	Communications Equipment	10.34	5.43	4.14	2.57	6.51
24	Electronic Components	12.27	11.12	7.58	5.64	10.37
25	Other Electrical Machinery	10.00	5.78	3.40	0.81	6.24
26	Motor Vehicles	16.38	6.06	2.73	0.72	8.33
27	Other Transportation Equipment	11.40	2.95	2.91	0.36	5.37
28	Precision Instruments	14.86	6.80	2.46	-1.33	7.86
29	Other Manufacturing	16.11	4.11	3.50	1.95	7.66
30	Railroad Transportation	5.16	2.08	1.14	2.07	2.96
31	Road Transportation	12.46	7.22	-0.80	-1.69	6.81
32	Water Transportation	-0.47	0.80	0.23	-1.15	0.07
33	Air Transportation	17.58	5.52	-0.95	-1.49	7.75
34	Storage Facility Service	11.79	4.49	7.06	2.40	6.92
35	Communications	13.76	1.72	1.57	2.94	5.76
36	Electricity	4.15	5.42	4.91	3.62	4.72
37	Gas Supply	9.44	5.07	3.30	1.45	5.82
38	Water Supply	13.39	4.31	2.91	3.77	7.02
39	Wholesale and Retail	10.96	5.30	3.39	2.06	6.49
40	Finance and Insurance	9.18	3.92	4.78	0.00	5.25
41	Real Estate	11.48	6.31	4.02	1.65	7.12
42	Education	8.71	3.96	2.23	0.82	4.89
43	Research	10.05	5.67	2.34	3.26	6.38
44	Medical Care	14.94	9.55	5.79	5.16	10.28
45	Other Service	17.33	5.98	2.21	2.13	8.72
46	Public Administration	10.80	5.72	5.07	3.66	7.03
47	Household	7.12	5.10	3.95	2.01	5.23
	Average	11.49	4.15	2.66	0.64	5.91

Note: All figures are average annual growth rates.

Table 13: Industry Contribution to IT Capital Input by Subperiod

	1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1 Agriculture, Forestry, Fishery	0.26	0.13	-0.01	0.00	0.14
2 Coal Mining	0.02	0.00	0.00	0.00	0.01
3 Other Mining	0.06	0.00	0.00	0.00	0.02
4 Construction	0.35	0.36	0.28	0.21	0.33
5 Foods	0.33	0.12	0.04	0.07	0.17
6 Textile	0.04	0.02	0.00	0.00	0.02
7 Apparel	0.05	0.02	0.01	0.00	0.03
8 Woods and Related Products	0.00	0.01	0.00	0.00	0.00
9 Furniture and Fixture	0.01	0.01	0.00	0.00	0.01
10 Paper and Pulp	0.42	0.02	0.01	0.01	0.15
11 Printing and Publishing	0.18	0.13	0.07	0.07	0.13
12 Chemical Products	0.75	0.24	0.10	0.15	0.38
13 Petroleum Refining	0.15	0.04	0.01	0.03	0.07
14 Coal Products	0.00	0.01	0.00	0.00	0.01
15 Rubber Products	0.06	0.02	0.00	0.01	0.03
16 Leather Products	0.00	0.00	0.00	0.00	0.00
17 Stone, Clay, Glass	0.12	0.03	0.01	0.01	0.05
18 Iron and Steel	0.92	0.08	0.00	0.01	0.34
19 Non-ferrous Metal	0.15	0.04	0.00	0.01	0.07
20 Metal Products	0.21	0.08	0.00	0.00	0.10
21 Machinery	0.36	0.25	0.06	0.03	0.23
22 Computers	0.22	0.27	0.11	0.03	0.20
23 Communications Equipment	0.39	0.10	0.04	0.06	0.18
24 Electronic Components	0.76	0.57	0.22	0.24	0.55
25 Other Electrical Machinery	1.50	0.47	0.11	0.17	0.72
26 Motor Vehicles	0.78	0.11	0.05	0.05	0.31
27 Other Transportation Equipment	0.53	-0.01	0.00	0.00	0.17
28 Precision Instruments	0.07	0.09	0.03	0.02	0.07
29 Other Manufacturing	0.09	0.12	0.04	0.06	0.09
30 Railroad Transportation	0.04	0.06	0.07	0.10	0.06
31 Road Transportation	0.09	0.12	0.05	0.06	0.09
32 Water Transportation	0.12	-0.03	0.01	0.02	0.03
33 Air Transportation	0.05	0.01	0.00	0.00	0.02
34 Storage Facility Service	0.01	0.03	0.00	0.00	0.02
35 Communications	3.66	1.42	0.91	1.23	2.06
36 Electricity	0.47	0.42	0.19	0.09	0.37
37 Gas Supply	0.13	0.04	0.02	0.02	0.06
38 Water Supply	0.01	0.01	0.01	0.01	0.01
39 Wholesale and Retail	0.77	1.16	0.20	0.35	0.81
40 Finance and Insurance	3.05	1.67	0.82	2.06	2.06
41 Real Estate	0.04	0.08	0.01	0.06	0.06
42 Education	0.06	0.07	0.05	0.02	0.06
43 Research	0.02	0.03	0.00	0.01	0.02
44 Medical Care	0.52	0.18	0.19	0.17	0.29
45 Other Service	7.49	3.84	1.85	3.20	4.70
46 Public Administration	0.53	0.90	0.77	0.73	0.74
47 Household	0.17	0.55	0.87	1.88	0.63
Sum	26.02	13.89	7.23	11.26	16.67

Note: All figures are average annual contributions. Sum means annual average growth rate in IT capital input at economy-wide level.

Table 14: Industry Contribution to Non-IT Capital Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	0.18	0.06	-0.01	-0.02	0.08
2	Coal Mining	0.00	0.00	0.00	0.00	0.00
3	Other Mining	0.05	0.01	0.00	-0.01	0.02
4	Construction	0.58	0.26	0.71	0.07	0.40
5	Foods	0.35	0.10	0.04	0.02	0.16
6	Textile	0.08	0.00	0.00	0.00	0.03
7	Apparel	0.02	0.01	0.01	0.00	0.01
8	Woods and Related Products	0.05	0.00	0.00	0.00	0.02
9	Furniture and Fixture	0.04	0.01	0.01	0.00	0.02
10	Paper and Pulp	0.08	0.02	0.01	0.00	0.04
11	Printing and Publishing	0.12	0.02	0.03	0.01	0.05
12	Chemical Products	0.35	0.07	0.06	0.02	0.16
13	Petroleum Refining	0.18	0.00	0.02	0.01	0.06
14	Coal Products	0.02	0.00	0.00	0.00	0.01
15	Rubber Products	0.03	0.01	0.01	0.00	0.01
16	Leather Products	0.00	0.00	0.00	0.00	0.00
17	Stone, Clay, Glass	0.15	0.03	0.02	0.00	0.06
18	Iron and Steel	0.43	0.09	0.02	-0.01	0.18
19	Non-ferrous Metal	0.08	0.01	0.01	0.00	0.03
20	Metal Products	0.15	0.05	0.04	0.00	0.07
21	Machinery	0.40	0.11	0.08	0.01	0.19
22	Computers	0.02	0.04	0.02	0.00	0.03
23	Communications Equipment	0.01	0.01	0.01	0.00	0.01
24	Electronic Components	0.06	0.08	0.06	0.06	0.07
25	Other Electrical Machinery	0.24	0.11	0.06	0.01	0.13
26	Motor Vehicles	0.34	0.11	0.04	0.01	0.16
27	Other Transportation Equipment	0.05	0.01	0.01	0.00	0.02
28	Precision Instruments	0.06	0.02	0.01	0.00	0.03
29	Other Manufacturing	0.12	0.04	0.03	0.01	0.06
30	Railroad Transportation	0.05	0.01	0.01	0.01	0.03
31	Road Transportation	0.14	0.05	0.00	-0.01	0.07
32	Water Transportation	-0.02	0.00	0.00	0.00	0.00
33	Air Transportation	0.02	0.01	0.00	0.00	0.01
34	Storage Facility Service	0.02	0.01	0.01	0.00	0.01
35	Communications	0.16	0.03	0.02	0.04	0.07
36	Electricity	0.09	0.13	0.17	0.13	0.12
37	Gas Supply	0.03	0.02	0.01	0.01	0.02
38	Water Supply	0.04	0.01	0.02	0.03	0.03
39	Wholesale and Retail	0.89	0.41	0.21	0.06	0.50
40	Finance and Insurance	0.34	0.17	0.16	0.00	0.21
41	Real Estate	0.78	0.45	0.32	0.19	0.51
42	Education	0.04	0.03	0.02	0.01	0.03
43	Research	0.00	0.00	0.00	0.00	0.00
44	Medical Care	0.19	0.15	0.07	0.08	0.14
45	Other Service	0.96	0.44	0.19	0.24	0.55
46	Public Administration	0.40	0.29	0.29	0.25	0.32
47	Household	1.51	1.29	1.13	0.64	1.26
	Sum	9.92	4.80	3.91	1.87	5.99

Note: All figures are average annual contributions. Sum means annual average growth rate in Non-IT capital input at economy-wide level.

Table 15: IT Capital Share in Industry Capital Cost by Subperiod

		1960	1973	1990	1995	2000
1	Agriculture, Forestry, Fishery	0.07	0.83	1.43	0.70	1.06
2	Coal Mining	0.76	3.23	1.05	1.82	1.86
3	Other Mining	0.73	0.89	1.14	1.31	1.51
4	Construction	0.39	0.94	2.39	2.71	4.79
5	Foods	0.40	1.28	4.33	4.43	5.04
6	Textile	0.15	0.91	5.14	8.54	9.04
7	Apparel	1.42	2.81	4.61	8.48	13.89
8	Woods and Related Products	0.01	0.14	1.68	2.89	3.43
9	Furniture and Fixture	0.03	0.30	2.55	5.78	5.79
10	Paper and Pulp	2.46	5.10	2.52	2.33	2.93
11	Printing and Publishing	0.95	2.50	12.02	17.67	25.09
12	Chemical Products	1.29	2.85	5.43	5.31	8.82
13	Petroleum Refining	0.63	0.83	4.89	2.87	3.57
14	Coal Products	0.13	0.34	2.82	2.82	4.07
15	Rubber Products	0.87	3.11	4.75	8.76	10.33
16	Leather Products	0.04	0.19	2.38	4.43	4.96
17	Stone, Clay, Glass	0.46	0.83	2.35	4.66	6.77
18	Iron and Steel	0.93	2.48	3.02	2.65	2.93
19	Non-ferrous Metal	0.89	1.53	4.54	4.40	5.78
20	Metal Products	1.03	1.56	5.50	6.22	8.21
21	Machinery	0.53	2.22	4.24	6.28	8.00
22	Computers	10.29	23.17	23.48	37.98	46.86
23	Communications Equipment	16.93	26.99	29.96	37.54	36.88
24	Electronic Components	8.15	13.38	28.20	25.29	24.39
25	Other Electrical Machinery	2.98	7.27	12.64	15.17	17.74
26	Motor Vehicles	1.97	2.63	5.11	6.55	8.52
27	Other Transportation Equipment	8.55	18.00	8.35	9.15	9.22
28	Precision Instruments	0.83	2.31	15.05	20.03	21.01
29	Other Manufacturing	0.49	1.38	5.73	10.16	13.71
30	Railroad Transportation	0.34	0.75	4.54	8.49	16.76
31	Road Transportation	0.30	1.26	4.52	8.62	12.62
32	Water Transportation	4.75	19.24	4.14	5.64	8.83
33	Air Transportation	1.74	4.99	5.56	6.63	7.22
34	Storage Facility Service	0.16	0.80	9.48	7.97	10.00
35	Communications	18.53	20.30	33.91	40.22	40.32
36	Electricity	1.55	5.85	6.60	6.36	6.63
37	Gas Supply	1.73	5.81	7.90	7.61	8.63
38	Water Supply	0.03	0.14	1.39	1.25	1.85
39	Wholesale and Retail	0.39	1.38	7.86	9.90	18.83
40	Finance and Insurance	3.28	6.12	18.22	24.99	34.45
41	Real Estate	0.01	0.12	0.61	0.32	0.59
42	Education	0.22	1.33	3.11	5.27	3.84
43	Research	2.15	7.22	16.52	27.21	22.22
44	Medical Care	1.26	2.44	3.12	7.93	7.58
45	Other Service	2.84	10.33	18.32	17.15	21.60
46	Public Administration	0.77	1.90	5.79	7.98	7.93
47	Household	0.06	0.09	0.70	1.40	3.02
	Economy-wide level	1.18	2.65	6.45	7.20	9.83

Note: All figures are shares.

Table 16: Growth of Industry Labor Input by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	-2.48	-2.04	-4.94	-4.35	-2.83
2	Coal Mining	-18.52	-6.39	-10.15	-21.02	-12.63
3	Other Mining	-5.13	-4.25	-1.72	-3.72	-4.15
4	Construction	4.43	2.34	1.34	-0.17	2.58
5	Foods	3.08	3.20	1.52	-1.45	2.37
6	Textile	-0.60	-4.39	-4.26	-9.58	-3.79
7	Apparel	3.32	1.76	-5.06	-9.12	0.05
8	Woods and Related Products	0.97	-2.40	-1.93	-4.83	-1.55
9	Furniture and Fixture	6.47	-0.63	-3.11	-3.28	1.04
10	Paper and Pulp	0.96	1.61	-1.27	-2.72	0.50
11	Printing and Publishing	3.83	3.27	0.94	-0.32	2.72
12	Chemical Products	1.23	0.92	0.23	-0.23	0.79
13	Petroleum Refining	5.18	-0.83	0.84	-2.03	1.18
14	Coal Products	0.30	-1.03	-2.24	-6.18	-1.39
15	Rubber Products	0.36	1.21	0.04	-2.04	0.38
16	Leather Products	7.33	-0.23	0.19	-6.93	1.44
17	Stone, Clay, Glass	2.52	0.78	-0.34	-2.19	0.83
18	Iron and Steel	0.96	0.66	-1.92	-3.89	-0.13
19	Non-ferrous Metal	4.52	-0.33	-3.78	-2.74	0.51
20	Metal Products	4.74	0.28	-1.72	-1.83	1.22
21	Machinery	4.60	2.04	-1.12	1.43	2.40
22	Computers	26.77	10.02	-7.18	-13.20	10.41
23	Communications Equipment	1.64	1.55	2.37	0.90	1.60
24	Electronic Components	-1.13	5.60	4.24	-0.14	2.53
25	Other Electrical Machinery	2.18	3.47	-4.12	0.67	1.75
26	Motor Vehicles	5.99	0.50	-1.71	-0.98	1.82
27	Other Transportation Equipment	-0.65	-1.93	-3.99	-0.24	-1.56
28	Precision Instruments	4.37	1.28	-4.50	-1.22	1.25
29	Other Manufacturing	6.08	2.09	0.46	-2.58	2.60
30	Railroad Transportation	-0.47	-2.08	0.29	-3.54	-1.44
31	Road Transportation	6.30	2.55	0.73	-1.51	3.04
32	Water Transportation	1.09	-0.43	0.52	-4.79	-0.36
33	Air Transportation	13.85	5.08	0.12	-1.45	6.49
34	Storage Facility Service	4.82	2.24	-2.08	-2.39	1.96
35	Communications	4.19	1.78	-0.49	6.48	2.87
36	Electricity	2.45	1.25	3.42	-2.34	1.46
37	Gas Supply	0.08	-0.87	5.63	0.52	0.42
38	Water Supply	10.39	0.46	1.35	1.15	3.88
39	Wholesale and Retail	3.97	2.05	-0.84	-0.54	1.99
40	Finance and Insurance	4.05	3.57	0.56	-2.13	2.64
41	Real Estate	14.57	3.56	1.48	-0.05	6.43
42	Education	3.41	3.41	-1.13	0.26	2.45
43	Research	7.42	3.18	3.20	1.17	4.31
44	Medical Care	6.73	3.82	2.71	3.62	4.60
45	Other Service	8.41	2.60	-0.35	0.88	3.91
46	Public Administration	5.12	1.77	-0.78	-1.92	2.08
47	Household	0.00	0.00	0.00	0.00	0.00
	Average	3.61	1.11	-0.82	-2.35	1.25

Note: All figures are average annual growth rates.

Table 17: Sources of Industry Output Growth, 1960-2000

	Output	Capital	Labor	Intermediate	TFP
1 Agriculture, Forestry, Fishery	0.64	0.36	-0.78	0.38	0.69
2 Coal Mining	-7.17	-0.06	-5.11	-3.05	1.05
3 Other Mining	3.43	1.02	-0.87	1.36	1.92
4 Construction	4.38	0.95	0.63	3.18	-0.38
5 Foods	3.82	0.82	0.28	2.61	0.11
6 Textile	0.16	0.19	-1.08	-0.40	1.45
7 Apparel	2.74	0.37	-0.16	2.35	0.19
8 Woods and Related Products	1.07	0.25	-0.35	0.83	0.33
9 Furniture and Fixture	3.62	0.70	0.13	2.67	0.12
10 Paper and Pulp	4.06	0.62	0.04	2.36	1.04
11 Printing and Publishing	3.90	1.15	0.80	2.89	-0.95
12 Chemical Products	5.67	1.00	0.09	2.86	1.72
13 Petroleum Refining	5.23	1.46	0.04	2.80	0.92
14 Coal Products	4.19	0.52	-0.10	3.42	0.35
15 Rubber Products	4.73	0.69	0.07	2.75	1.22
16 Leather Products	2.88	0.27	0.11	2.26	0.24
17 Stone, Clay, Glass	4.26	0.98	0.15	2.36	0.77
18 Iron and Steel	3.77	0.63	-0.05	2.53	0.65
19 Non-ferrous Metal	4.94	0.65	-0.01	3.04	1.25
20 Metal Products	5.65	0.89	0.31	3.37	1.08
21 Machinery	6.69	1.05	0.47	4.15	1.02
22 Computers	26.80	3.21	2.09	14.63	6.86
23 Communications Equipment	12.39	0.94	0.35	7.64	3.46
24 Electronic Components	17.21	2.19	0.41	7.02	7.59
25 Other Electrical Machinery	7.70	1.04	0.29	4.31	2.05
26 Motor Vehicles	8.37	1.03	0.30	5.30	1.73
27 Other Transportation Equipment	3.06	0.59	-0.41	2.13	0.75
28 Precision Instruments	6.81	1.07	0.28	3.37	2.09
29 Other Manufacturing	7.06	1.07	0.46	4.44	1.08
30 Railroad Transportation	2.02	0.66	-0.36	2.18	-0.45
31 Road Transportation	4.54	0.92	1.55	2.14	-0.07
32 Water Transportation	3.48	-0.02	-0.07	2.02	1.56
33 Air Transportation	11.99	1.37	1.72	5.93	2.97
34 Storage Facility Service	5.09	1.10	0.85	2.57	0.58
35 Communications	8.31	2.61	1.18	1.86	2.66
36 Electricity	5.74	2.08	0.19	1.98	1.55
37 Gas Supply	5.61	2.11	0.11	1.84	1.55
38 Water Supply	5.33	3.06	1.14	2.29	-1.17
39 Wholesale and Retail	5.67	1.22	0.77	1.71	1.96
40 Finance and Insurance	6.27	1.98	0.99	1.67	1.65
41 Real Estate	4.63	5.87	0.44	0.69	-2.36
42 Education	1.61	0.39	1.78	0.81	-1.37
43 Research	5.84	0.56	2.80	1.67	0.82
44 Medical Care	6.90	1.49	1.94	3.68	-0.22
45 Other Service	4.76	1.90	0.97	3.34	-1.45
46 Public Administration	4.73	2.25	1.06	1.41	0.00
47 Household	5.58	4.93	0.00	0.66	0.00
Industry Median	4.76	0.98	0.28	2.53	1.02

Note: The contribution of each input represents the share-weighted growth rate. All figures are average annual percentages.

Table 18: Sources of Industry Labor Productivity Growth, 1960-2000

	ALP	Capital Deepening	Intermediate Deepening	Labor Quality	TFP
1 Agriculture, Forestry, Fishery	4.36	1.39	2.03	0.26	0.69
2 Coal Mining	6.19	1.78	3.04	0.32	1.05
3 Other Mining	8.04	2.49	3.53	0.11	1.92
4 Construction	2.31	0.73	1.82	0.14	-0.38
5 Foods	2.10	0.57	1.32	0.09	0.11
6 Textile	4.73	0.35	2.73	0.20	1.45
7 Apparel	3.19	0.41	2.47	0.13	0.19
8 Woods and Related Products	2.88	0.36	2.13	0.05	0.33
9 Furniture and Fixture	3.05	0.56	2.25	0.12	0.12
10 Paper and Pulp	4.28	0.68	2.46	0.10	1.04
11 Printing and Publishing	1.94	0.85	1.79	0.24	-0.95
12 Chemical Products	5.66	1.00	2.84	0.10	1.72
13 Petroleum Refining	4.82	1.06	2.82	0.02	0.92
14 Coal Products	6.31	1.00	4.92	0.04	0.35
15 Rubber Products	5.10	0.72	2.99	0.18	1.22
16 Leather Products	2.07	0.17	1.50	0.16	0.24
17 Stone, Clay, Glass	4.13	0.88	2.31	0.17	0.77
18 Iron and Steel	4.56	0.77	3.10	0.05	0.65
19 Non-ferrous Metal	4.91	0.64	2.97	0.05	1.25
20 Metal Products	4.99	0.79	2.96	0.16	1.08
21 Machinery	5.00	0.78	3.05	0.16	1.02
22 Computers	17.19	1.20	8.99	0.14	6.86
23 Communications Equipment	11.60	0.87	7.12	0.15	3.46
24 Electronic Components	15.49	1.87	5.88	0.15	7.59
25 Other Electrical Machinery	6.75	0.88	3.65	0.17	2.05
26 Motor Vehicles	7.37	0.87	4.62	0.14	1.73
27 Other Transportation Equipment	5.15	0.78	3.49	0.14	0.75
28 Precision Instruments	6.42	0.99	3.09	0.24	2.09
29 Other Manufacturing	5.25	0.82	3.19	0.16	1.08
30 Railroad Transportation	4.27	1.17	3.24	0.32	-0.45
31 Road Transportation	1.85	0.48	1.21	0.23	-0.07
32 Water Transportation	4.25	-0.09	2.67	0.11	1.56
33 Air Transportation	5.55	0.25	2.29	0.04	2.97
34 Storage Facility Service	3.32	0.78	1.87	0.09	0.58
35 Communications	6.14	1.92	1.27	0.29	2.66
36 Electricity	4.52	1.61	1.33	0.03	1.55
37 Gas Supply	5.34	1.90	1.87	0.02	1.55
38 Water Supply	2.06	1.43	1.62	0.18	-1.17
39 Wholesale and Retail	4.41	1.03	1.14	0.28	1.96
40 Finance and Insurance	4.21	1.30	1.03	0.23	1.65
41 Real Estate	-1.58	0.64	0.10	0.04	-2.36
42 Education	-0.37	0.24	0.41	0.35	-1.37
43 Research	1.95	0.24	0.61	0.28	0.82
44 Medical Care	2.74	0.87	1.89	0.20	-0.22
45 Other Service	1.74	1.27	1.66	0.26	-1.45
46 Public Administration	3.32	1.86	1.15	0.31	0.00
47 Household	0.00	0.00	0.00	0.00	0.00
Industry Median	3.24	0.45	1.62	0.20	0.70

Note: All figures are average annual percentages.

Table 19: Growth of Industry Total Factor Productivity by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	1.28	0.26	1.56	-0.29	0.69
2	Coal Mining	5.16	-2.02	1.14	0.72	1.05
3	Other Mining	6.67	-0.39	-4.08	3.41	1.92
4	Construction	-0.67	0.56	-2.13	-1.04	-0.38
5	Foods	1.96	-0.81	-1.17	-0.29	0.11
6	Textile	0.05	2.33	2.30	1.22	1.45
7	Apparel	1.27	0.06	-1.90	-0.11	0.19
8	Woods and Related Products	-0.41	1.10	-0.88	0.90	0.33
9	Furniture and Fixture	1.17	0.05	-2.18	-0.12	0.12
10	Paper and Pulp	2.28	0.56	0.03	0.46	1.04
11	Printing and Publishing	-1.69	-0.52	-1.32	-0.09	-0.95
12	Chemical Products	3.69	1.24	0.20	-0.28	1.72
13	Petroleum Refining	0.57	1.37	0.07	1.17	0.92
14	Coal Products	0.89	-0.41	-0.01	1.90	0.35
15	Rubber Products	3.02	0.98	-1.64	0.22	1.22
16	Leather Products	1.99	-0.36	-1.82	-0.22	0.24
17	Stone, Clay, Glass	3.02	-0.37	-0.63	0.19	0.77
18	Iron and Steel	1.18	0.30	0.37	0.76	0.65
19	Non-ferrous Metal	1.72	1.07	1.19	0.71	1.25
20	Metal Products	3.63	0.17	-0.93	-0.48	1.08
21	Machinery	1.85	1.34	-1.25	0.06	1.02
22	Computers	7.08	8.54	1.03	6.38	6.86
23	Communications Equipment	5.01	2.60	-1.24	7.07	3.46
24	Electronic Components	9.57	7.15	3.55	7.96	7.59
25	Other Electrical Machinery	3.77	0.70	0.12	4.11	2.05
26	Motor Vehicles	3.37	1.46	-0.02	0.17	1.73
27	Other Transportation Equipment	1.01	1.28	-1.20	0.21	0.75
28	Precision Instruments	3.90	1.81	-1.11	1.55	2.09
29	Other Manufacturing	2.88	0.49	-1.00	0.48	1.08
30	Railroad Transportation	0.35	-0.72	-0.33	-1.78	-0.45
31	Road Transportation	0.74	0.23	-2.51	-0.74	-0.07
32	Water Transportation	2.90	1.74	-0.55	-0.39	1.56
33	Air Transportation	6.55	1.35	2.55	-0.40	2.97
34	Storage Facility Service	-1.97	2.78	0.64	-0.36	0.58
35	Communications	2.74	2.30	2.75	3.58	2.66
36	Electricity	4.61	0.23	-0.34	-0.07	1.55
37	Gas Supply	1.33	1.75	1.39	1.57	1.55
38	Water Supply	-2.49	-0.21	-0.10	-2.08	-1.17
39	Wholesale and Retail	4.58	1.34	0.04	-0.80	1.96
40	Finance and Insurance	3.47	1.36	-2.76	2.27	1.65
41	Real Estate	-4.34	-2.79	0.56	1.33	-2.36
42	Education	1.32	-4.03	0.14	-0.83	-1.37
43	Research	1.89	1.16	-3.04	0.76	0.82
44	Medical Care	0.23	0.35	-0.32	-3.23	-0.22
45	Other Service	-3.84	-0.84	1.38	-0.12	-1.45
46	Public Administration	0.00	0.00	0.00	0.00	0.00
47	Household	0.00	0.00	0.00	0.00	0.00
	Average	1.99	0.78	-0.29	0.75	1.03

Note: All figures are average annual growth rates.

Table 20: Growth of Industry Labor Productivity by Subperiod

		1960-1973	1973-1990	1990-1995	1995-2000	1960-2000
1	Agriculture, Forestry, Fishery	5.82	3.81	4.32	2.51	4.36
2	Coal Mining	14.34	0.15	4.62	7.09	6.19
3	Other Mining	19.11	3.99	-3.02	4.08	8.04
4	Construction	5.81	1.70	-0.99	-1.44	2.31
5	Foods	6.26	0.14	-1.02	1.03	2.10
6	Textile	5.08	5.60	1.73	3.86	4.73
7	Apparel	6.08	2.38	0.87	0.80	3.19
8	Woods and Related Products	5.42	2.37	0.55	0.35	2.88
9	Furniture and Fixture	7.74	1.80	0.22	-2.08	3.05
10	Paper and Pulp	10.64	1.29	0.49	1.71	4.28
11	Printing and Publishing	4.68	0.98	-0.66	0.63	1.94
12	Chemical Products	12.27	3.50	0.95	0.53	5.66
13	Petroleum Refining	9.35	2.44	3.11	2.82	4.82
14	Coal Products	12.12	2.42	1.54	9.19	6.31
15	Rubber Products	10.76	3.82	-1.57	1.43	5.10
16	Leather Products	7.06	0.92	-4.79	-0.17	2.07
17	Stone, Clay, Glass	11.77	0.61	-0.16	0.52	4.13
18	Iron and Steel	11.72	0.42	0.25	4.35	4.56
19	Non-ferrous Metal	8.57	2.98	4.36	2.53	4.91
20	Metal Products	11.72	2.66	1.30	-0.88	4.99
21	Machinery	10.15	4.14	-0.08	-0.34	5.00
22	Computers	19.82	14.22	13.23	24.40	17.19
23	Communications Equipment	16.98	9.01	2.77	15.23	11.60
24	Electronic Components	23.09	12.51	6.14	15.19	15.49
25	Other Electrical Machinery	12.97	2.69	5.25	5.88	6.75
26	Motor Vehicles	12.32	6.56	2.05	2.54	7.37
27	Other Transportation Equipment	9.51	4.58	0.65	0.23	5.15
28	Precision Instruments	11.63	4.77	1.97	2.94	6.42
29	Other Manufacturing	11.23	3.24	-0.38	2.17	5.25
30	Railroad Transportation	5.82	4.27	0.98	3.55	4.27
31	Road Transportation	3.18	2.29	-1.84	0.60	1.85
32	Water Transportation	7.16	4.21	-2.29	3.37	4.25
33	Air Transportation	9.58	3.38	4.44	3.59	5.55
34	Storage Facility Service	3.17	4.00	0.38	4.33	3.32
35	Communications	7.48	5.05	7.18	5.37	6.14
36	Electricity	9.03	2.39	-0.30	4.86	4.52
37	Gas Supply	7.52	6.08	-0.66	3.19	5.34
38	Water Supply	1.24	4.14	-0.42	-0.34	2.06
39	Wholesale and Retail	8.61	3.95	2.42	-2.95	4.41
40	Finance and Insurance	6.40	3.40	-1.42	6.89	4.21
41	Real Estate	-7.82	0.71	2.73	2.54	-1.58
42	Education	2.48	-3.04	1.62	-0.65	-0.37
43	Research	2.97	3.04	-3.21	0.77	1.95
44	Medical Care	4.78	3.30	1.01	-2.74	2.74
45	Other Service	-0.61	2.37	5.12	2.30	1.74
46	Public Administration	2.87	2.83	4.20	5.31	3.32
47	Household	0.00	0.00	0.00	0.00	0.00
	Average	8.25	3.36	1.35	3.13	4.67

Note: All figures are average annual growth rates.

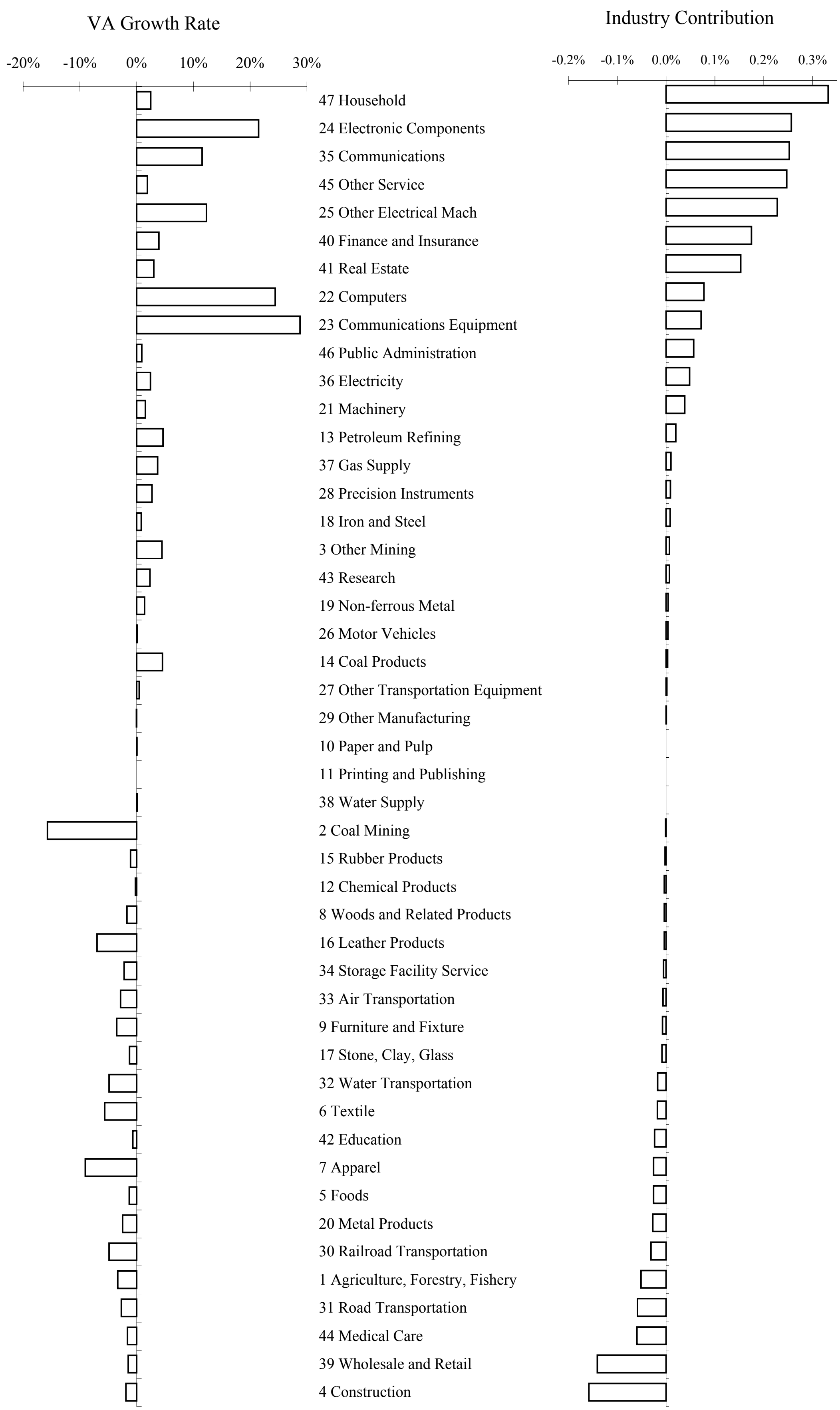

Figure 1: Value Added Growth and Industry Contribution during 1995-2000

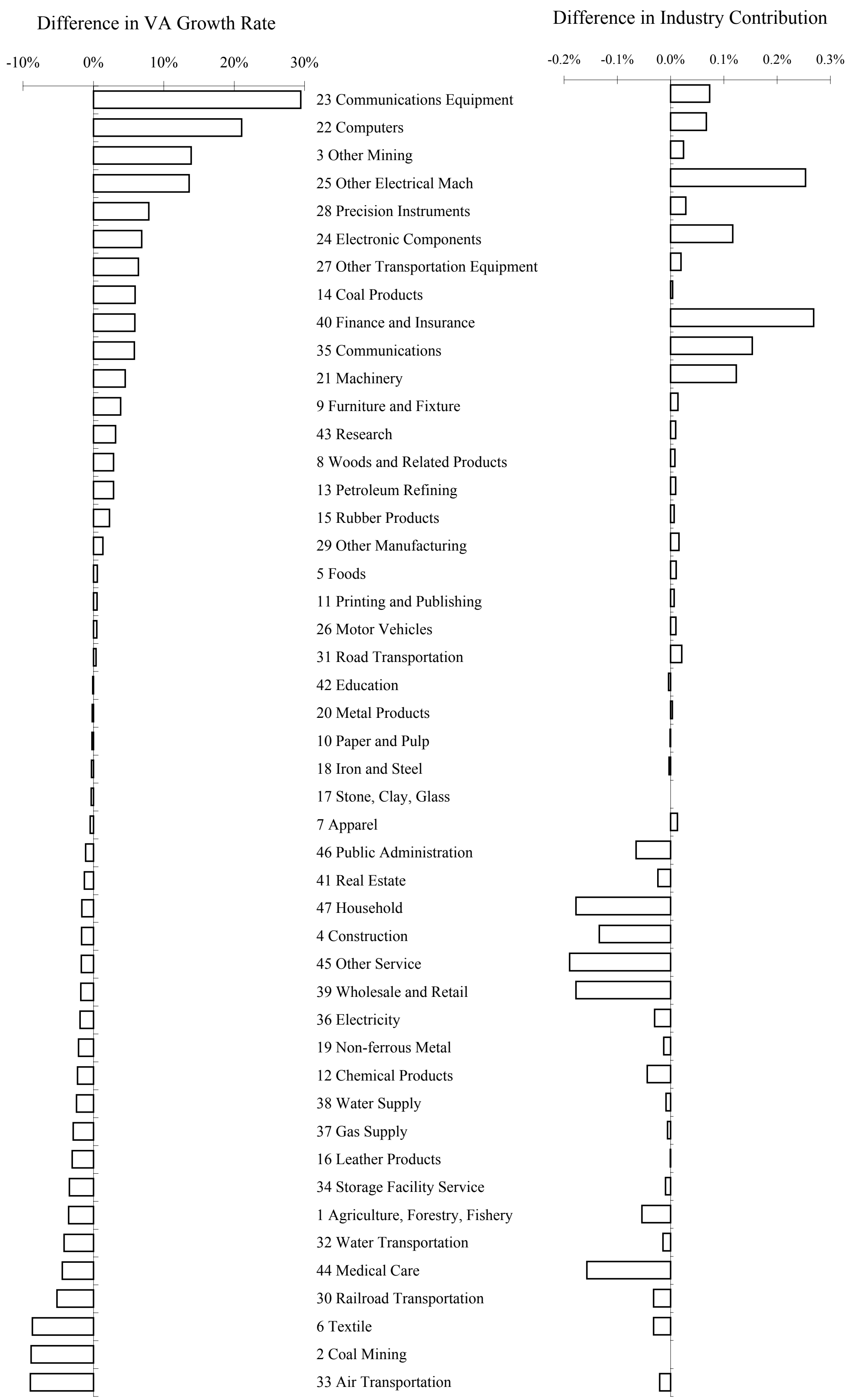

Figure 2: Recovery of Industry Value Added: Difference from1990-1995 to 1995-2000

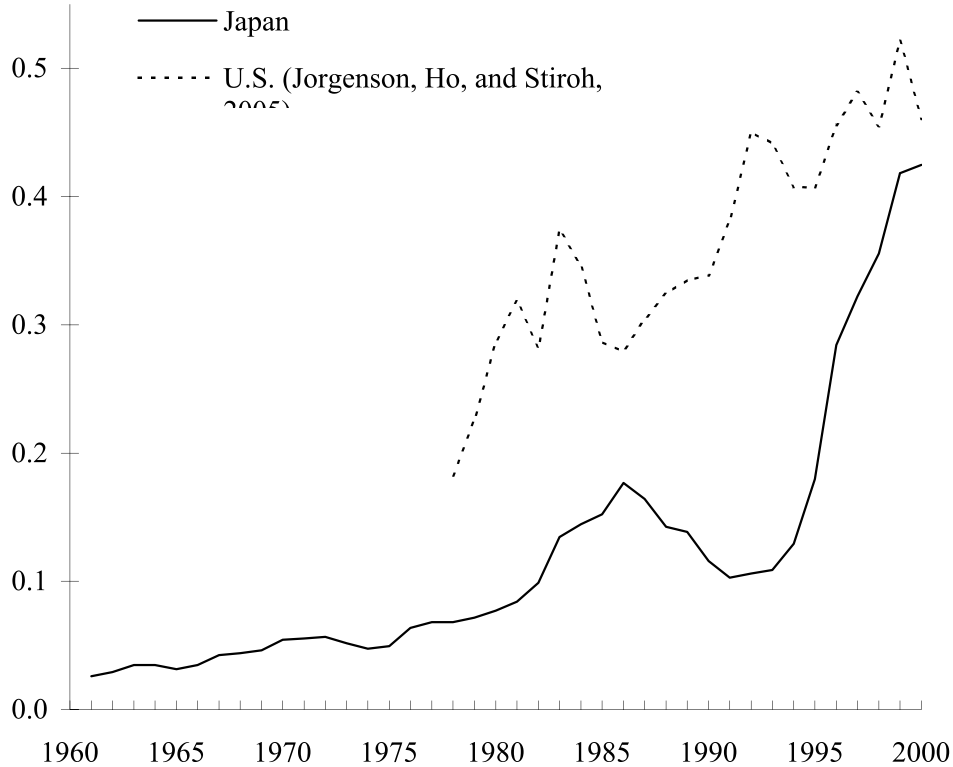

Figure 3: IT Capital Contribution to Total Capital Input: Comparison of the U.S. and Japan

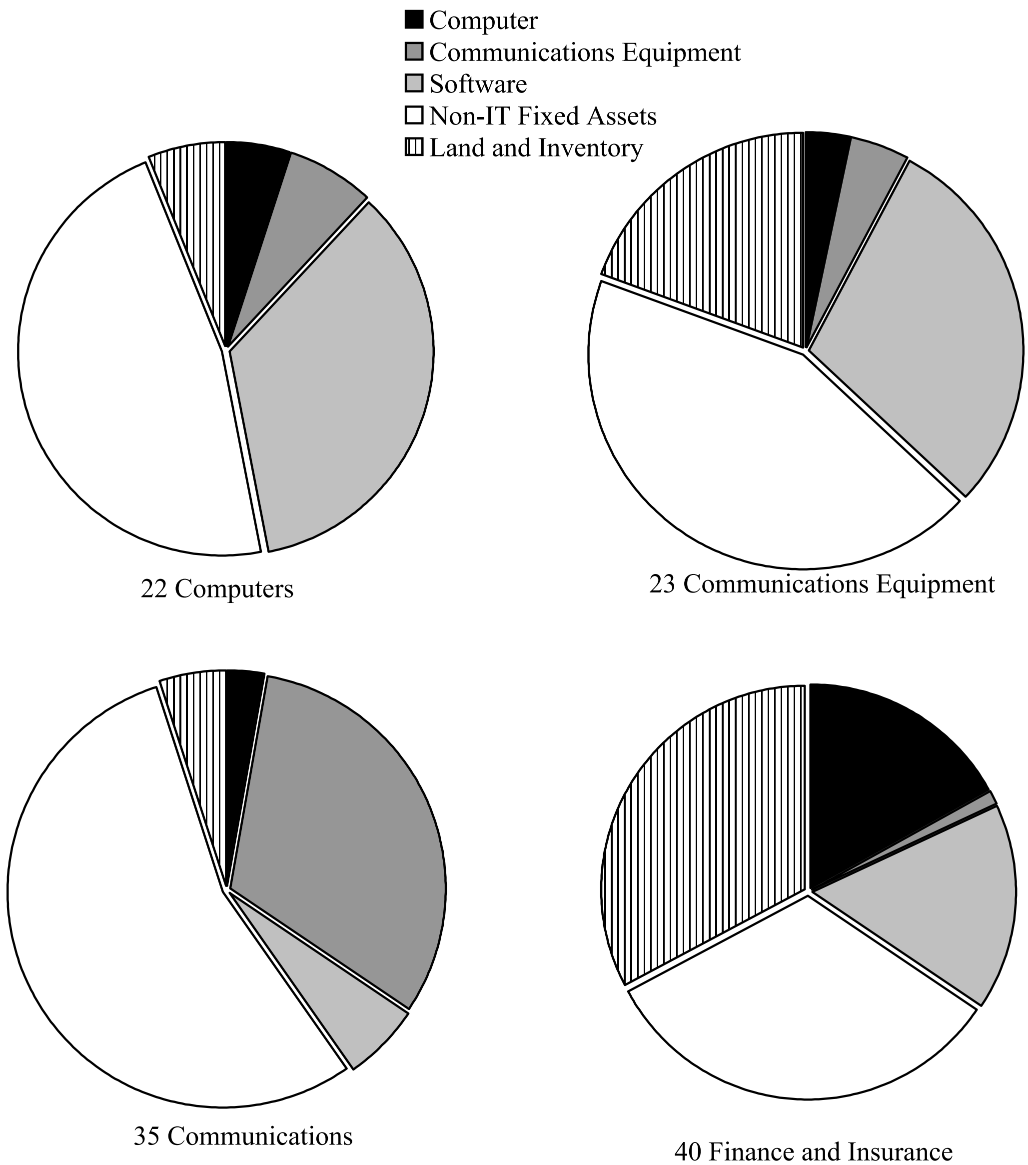

Figure 4: Capital Cost Structure in Selected High IT-Capital Intensive Industies

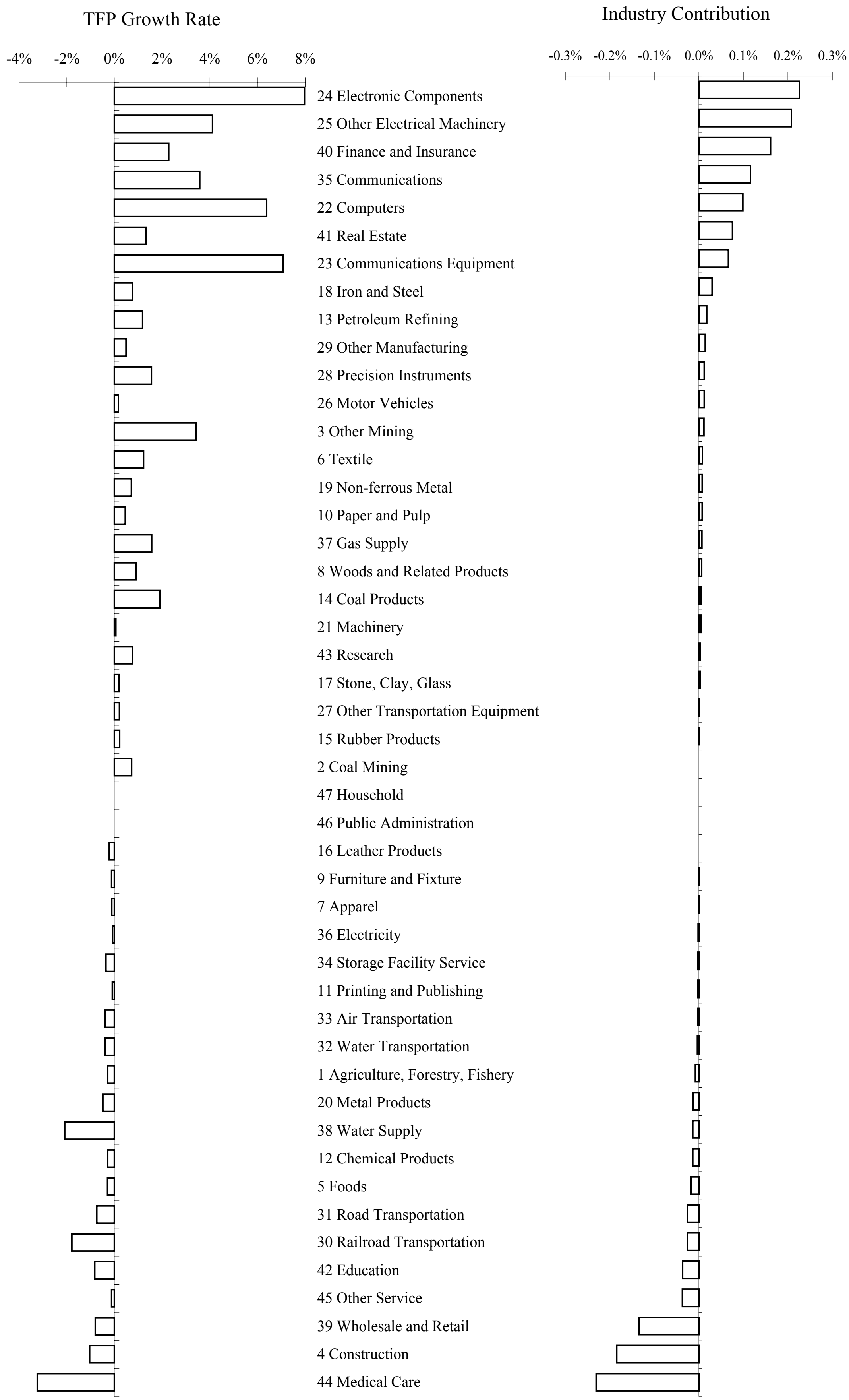

Figure 5: TFP Growth and Industry Contribution during 1995-2000

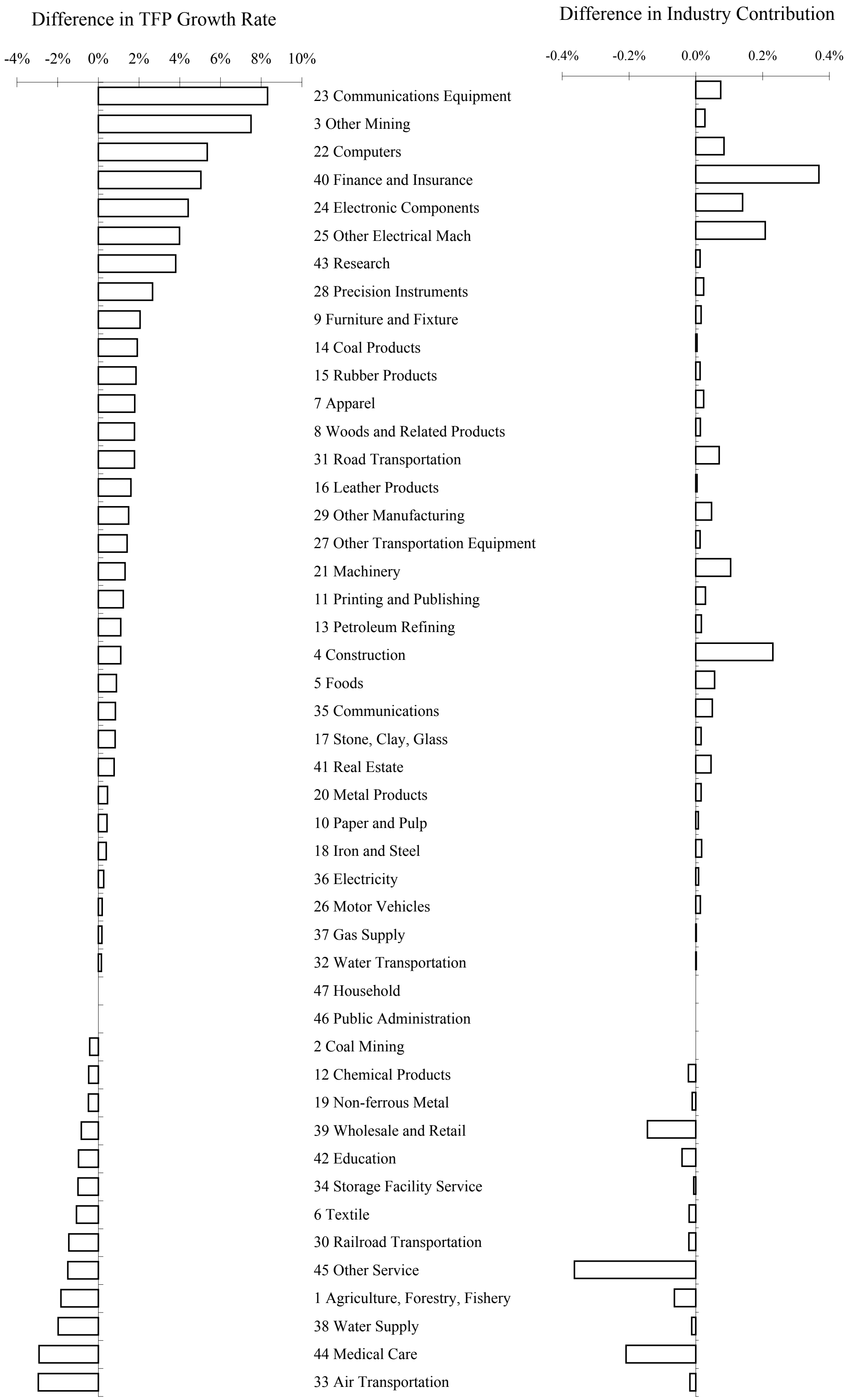

Figure 6: Recovery of Industry TFP: Difference from1990-1995 to 1995-2000

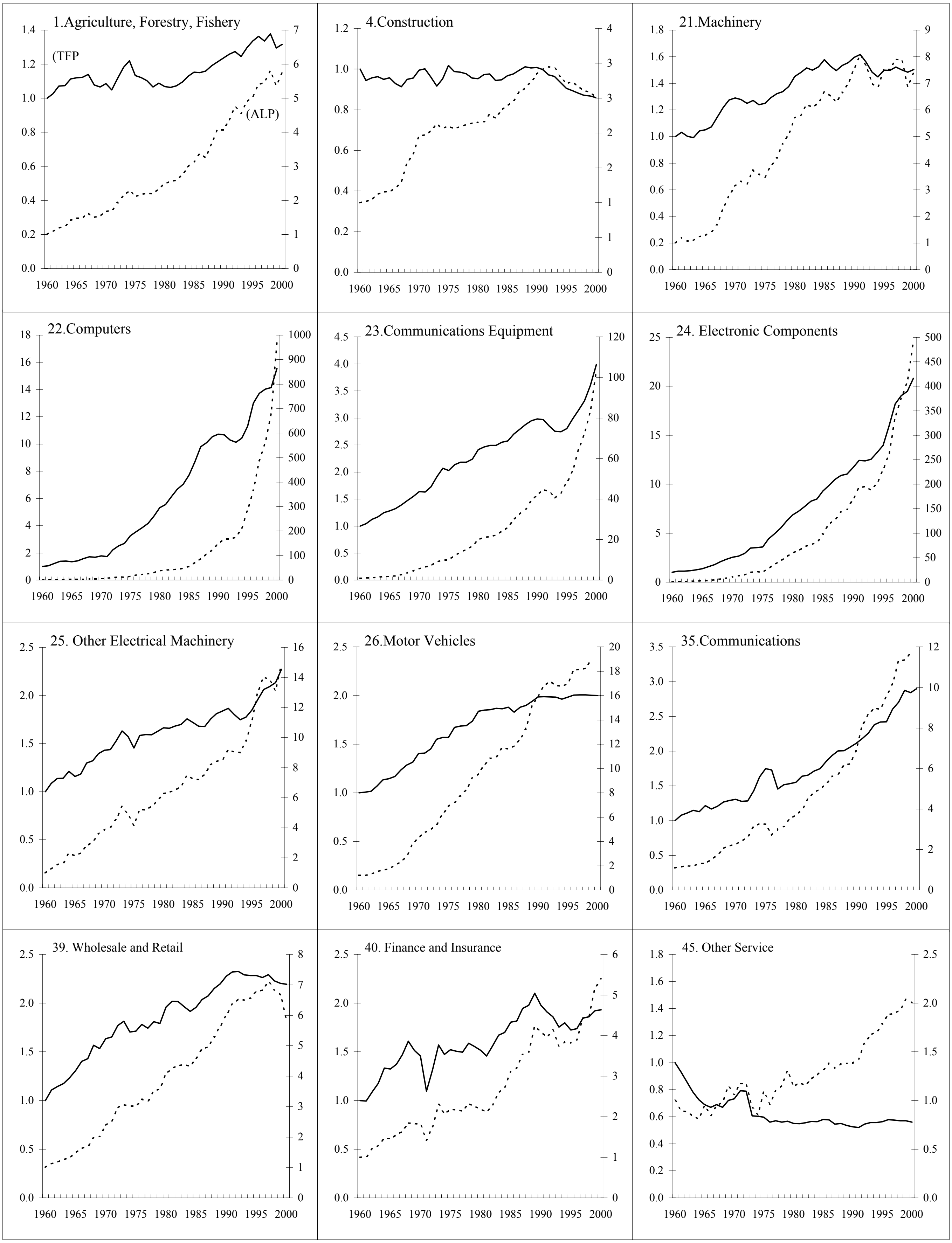

Figure 7: Indexes for TFP and Labor Productivity in Selected Industries